POWER

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The Engineer and His Position

THE era of efficiency having arrived, what has the operating engineer done to prepare himself to meet it?

Operating a power plant, whether it is in a hotel, mill, office building or railway station, is not what it was some years ago.

Power-plant engineering has advanced rapidly in recent years, and for the engineer to keep pace with it requires continuous study. If he does not read and become acquainted with the new appliances and methods that are being introduced, he will slide into a rut and hold his position only until the owner becomes convinced that he can find someone who can operate the plant efficiently.

DOES your plant operate efficiently? If not, are you to blame, or is it the boss' fault? If you're guilty, how long do you think the owner is going to keep you when there are others competent to handle your job and glad of the chance?

When a manufacturer finds that competitors sell the same goods for less than he can, he investigates the cause. If an expert reports that one great contributing cause is poor plant management, who "gets it in the neck"?

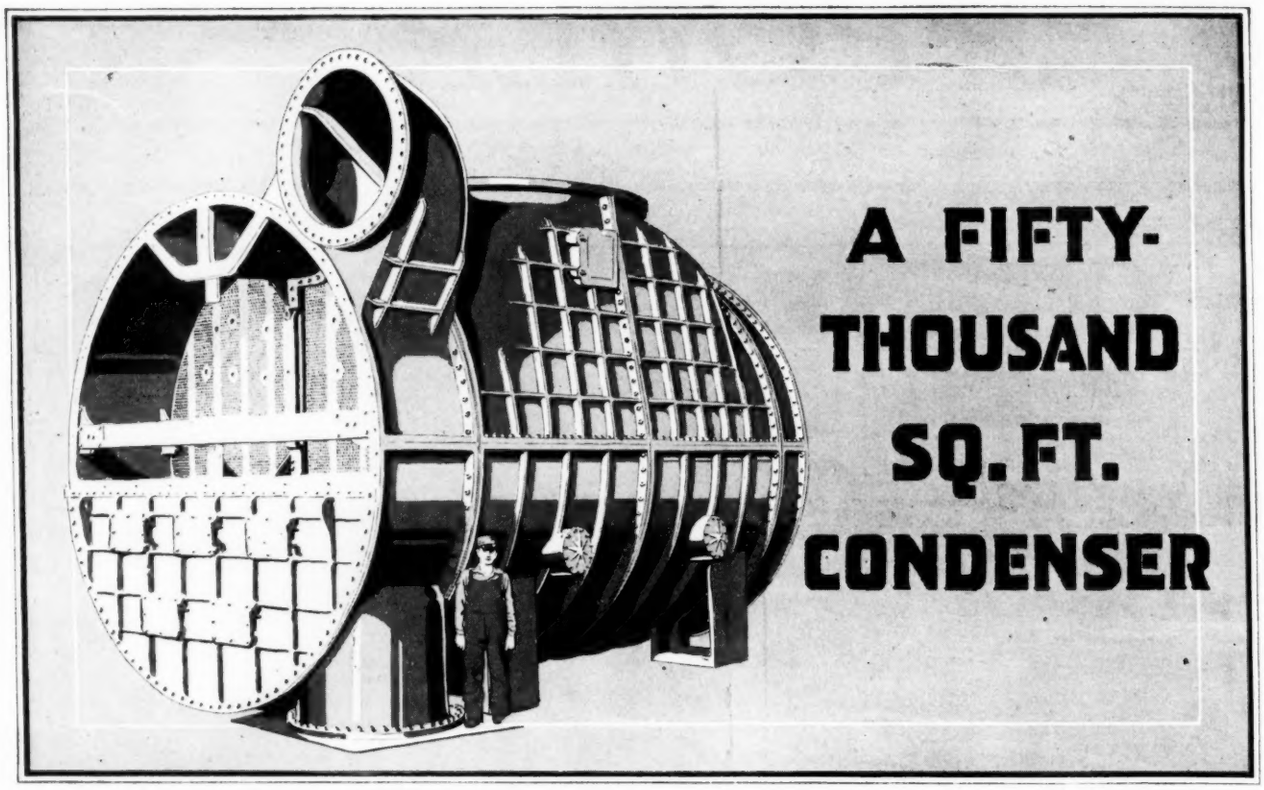
Sometimes it is difficult to operate efficiently because you have not the equipment for doing so, but no matter how bad the machinery or equipment may be, you can make an attempt at keeping a record sheet or log. When this is done, it is convincing proof that you are onto the job.

Your vest pocket is not the place for a log or record sheet. Keep it where it will create a healthy rivalry between the men, and also get their cooperation. That is what makes for success.

UNITY in the department should be the watchword. It is a pleasure to see the competition between the men, as one watch is trying to beat the record of the other, and you, checking up each day, are devising some way to make a better record than the previous one.

After you have started to keep up-to-date records, possibly you find you do not have the instruments or apparatus necessary to keep them accurately, but if you will take the matter up with the manager and a good reason is shown him why you should have them, he will, no doubt, after seeing what you are striving for and knowing that it is going to save money, acquiesce and give you all the assistance desired. It is then that you are headed right and becoming the kind of man the management wants you to be, the kind you want to be and the kind your fellows like to call acquaintance and friend. You are then headed for a better job.

Contributed by David Larkin, Chief Engineer, Fifth Avenue Building, New York City.



A FIFTY-THOUSAND SQ. FT. CONDENSER

A surface condenser having 50,000 sq.ft. of cooling surface, serves a 30,000-kw. turbine. The condenser is in a pit 74 ft. deep, and the exhaust pipe between the turbine and the condenser is 13 ft. diameter and 40 ft. long. It is provided with a special design of expansion joint. The circulating pump is below the low-level stage of the river.

WITH the increase in the capacity of turbine-generator units for power-plant service the sizes of the condensers that serve them have also increased, and improvements and refinements in design have been made. Some of the notable condensers that have been developed and put in service during the last year or two are, for instance, the 50,000-sq.ft. surface condenser of the New York Edison Co., and also one of the Chicago Commonwealth Edison Co., that serves 30,000 kw. generators. Another large condenser, a Leblanc, serves a 45,000-kw. turbine of the Narragansett Electric Light Co., Providence, R. I. It is designed to handle 18,000,000 lb. of circulating water, condensing approximately 500,000 lb. of steam per hour, an equivalent of 36 lb. of circulating water per pound of steam. The largest condenser so far built is one for the Detroit Edison Co., which has 70,000 sq.ft. of cooling surface.

Another installation of large surface condensers, of which there will be six, the largest yet built of the Leblanc surface type, is to be located at the bottom of a pit 74 feet deep, Fig. 2. At present there are two 50,000-sq.ft. surface condensers that serve the two 30,000-kw. turbines installed in the present structure of the Windsor power plant of the American Gas and Electric Co. (See headpiece.)

Both condensers are of the straight downflow type, with the tubes so spaced that steam lanes are provided so that all parts of the cooling surface can do their proportionate share of the condensing and thus insure a minimum pressure drop between the steam inlet and the air-pump connection. Each condenser contains muntz-metal tubes, of 18 B.w.g. and 18 ft. long. The condensers are 18 ft. inside diameter and 25 ft. long. A portion of the tubes in the upper portion of the condenser, aggregating about 2400 sq.ft., are used as a primary feed-water heater through which the condensate is pumped before going to the two open feed-water heaters. The primary heater brings the temperature of the condensate up very near to that of the incoming steam. Each condenser is set below the turbine which it serves, as shown in Fig. 2. As the turbine must be above the highest point which the river reaches and the condenser must be low enough to avoid lifting the water at low stages, the 13-ft. diameter exhaust pipe is 40 ft. in length.

Expansion of the pipe and the vertical expansion of the condenser are taken care of by a mercury expansion joint, Fig. 1, designed especially for and constituting one of the really novel features of the installation. It is 13 ft. in diameter and consists mainly of a fairly close-fitting cast-iron sleeve so formed as to permit a manometric column of mercury to make a seal to prevent air leakage and at the same time permit of a free motion of the upper and the lower halves of the joints relative to each other. The upper part of the joint is built so that if for any reason the mercury arrangement part of it should fail, an ordinary slip joint with soft packing could be used. This is not installed, inasmuch as the mercury joint operates very well, but it is readily seen that in case the mercury joint should fail, the part of the joint around the gland and packing could be im-

mediately turned into an ordinary slip joint with soft packing in the part that is marked "Rope for Packing."

The dotted portion marked "Expansion Joint Clamping Block" is not used with the joint in service. This is simply an arrangement whereby the two portions of the joint can be firmly fastened together for shipment. That portion is removed after the joint is in place.

It was decided that this type of joint was necessary because the great vertical distance between the condensers and the turbines entailed an extraordinarily great expansion in case the apparatus should be much changed in temperature. The mercury expansion joint can take up an indefinite amount of expansion, whereas there would be a danger that a copper joint, with the great distortions necessary, would ultimately fail.

With each condenser is furnished a horizontal motor-driven circulating pump having a capacity of 50,000 gal. per min. There are also two motor-driven Leblanc

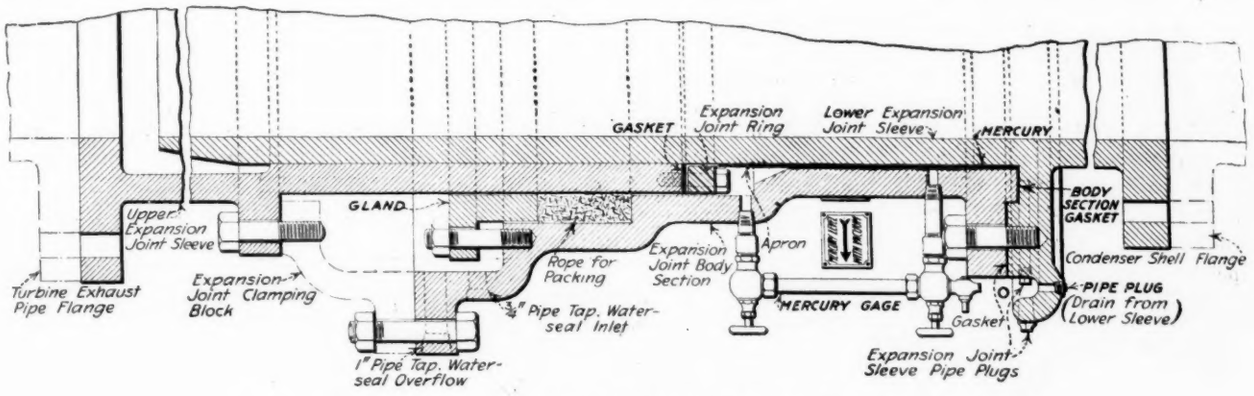


FIG. 1. DETAILS OF THE 13-FT. DIAMETER MERCURY EXPANSION JOINT

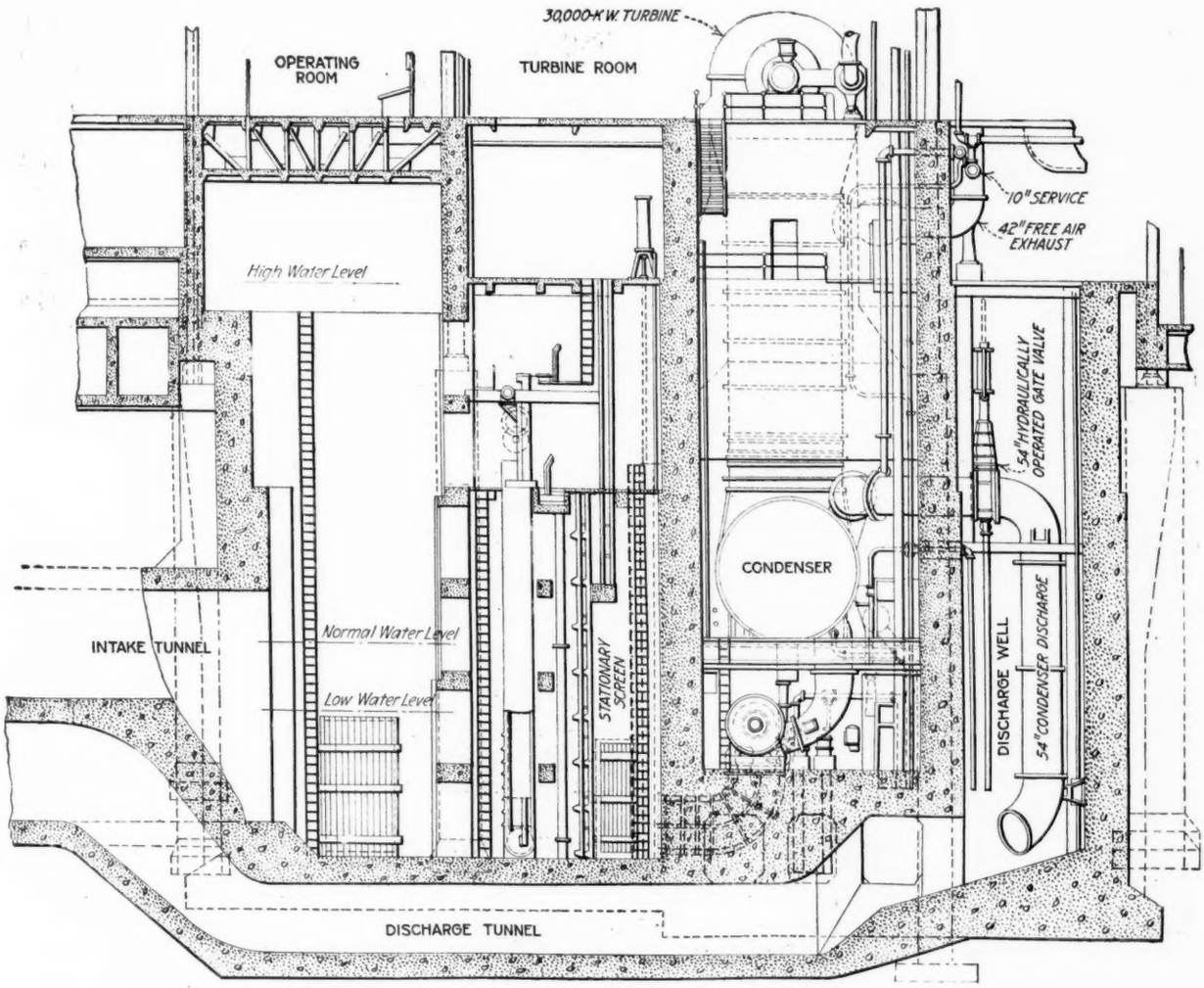


FIG. 2. ELEVATION OF THE INTAKE WELL AND CONDENSER PIT

rotary hydraulic-type air pumps and two motor-driven hotwell pumps. Water from these pumps is supplied from two steel tanks in the basement of the power plant, and it is discharged back into the tanks. Makeup water is taken from the discharge of the circulating pump. The centrifugal hotwell pumps are driven by 550-volt three-phase 60-cycle squirrel-cage induction motors that are provided with special insulation to withstand the damp atmosphere of the pit.

At this writing no plant tests have been made on the turbines, but assuming 12 lb. of steam per kilowatt-hour, each condenser will take care of 360,000 lb. of steam at rating or 7.2 lb. per sq.ft. of cooling surface and 8.3 gal. of circulating water per pound of steam condensed at rating. Per kilowatt of generator rating the condenser contains 1.67 sq.ft. of cooling surface.

The opening into the condenser pit is centrally between the steam ends of the two turbines, the foundations of which are formed by the walls of the condenser pit. The Ohio River at Windsor has a rise of 50 ft. from extreme-low to extreme-high water, which necessitated the construction of a condenser pit with the bottom 74 ft. below the turbine-room floor. The basement floor is just above the high-water mark, and the main floor is 18 ft. higher. With the condenser-pit floor 74 ft. below the turbines, it was possible to place the center line of the circulating pumps at the same elevation with the extreme low level of the river, thus reducing the cost of pumping the circulating water to a minimum.

Steel cross members support the condenser at a height of about 15 ft. above the floor of the condenser pit, which provides space for the circulating air and hotwell pumps. The concrete intake and discharge tunnels for the condensing water are built to take care of the proposed ultimate capacity of 200,000 kw. Water coming from the Ohio River through the intake tunnel goes to an intake crib inside the turbine room at the condenser well of Nos. 1 and 2 condensers. From this crib the water passes successively through bar-iron grills, traveling screens and stationary screens to a rear chamber of the crib. The 84-in. diameter cast-iron suction pipe of the circulating pumps drops to this chamber. Water from the condensers discharges from a side outlet on the upper side at one end through a 54-in. cast-iron pipe into a discharge well that connects to the discharge tunnel, and is returned to the river below the intake.

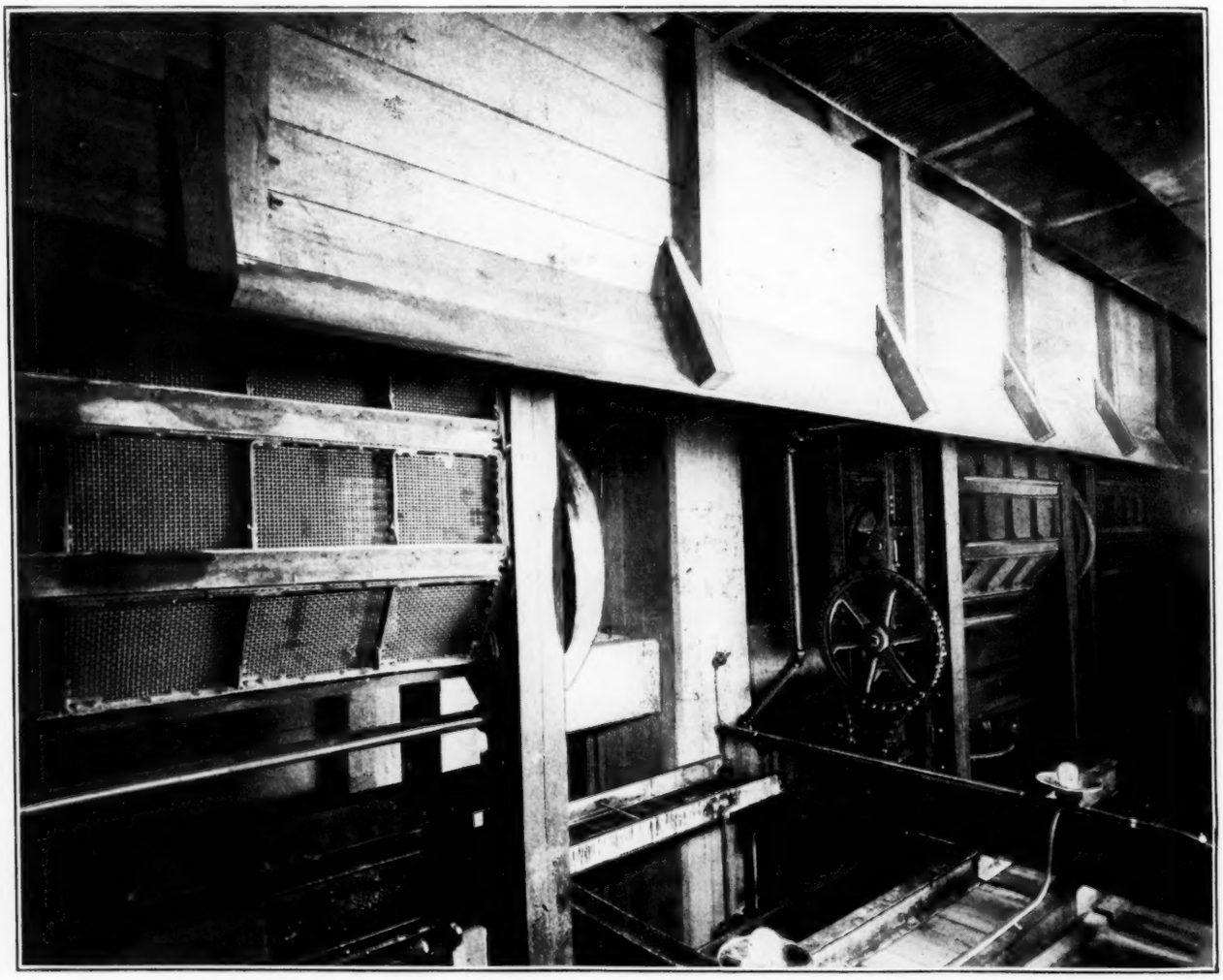


FIG. 3. VERTICAL REVOLVING SCREENS AT THE INTAKE TUNNEL

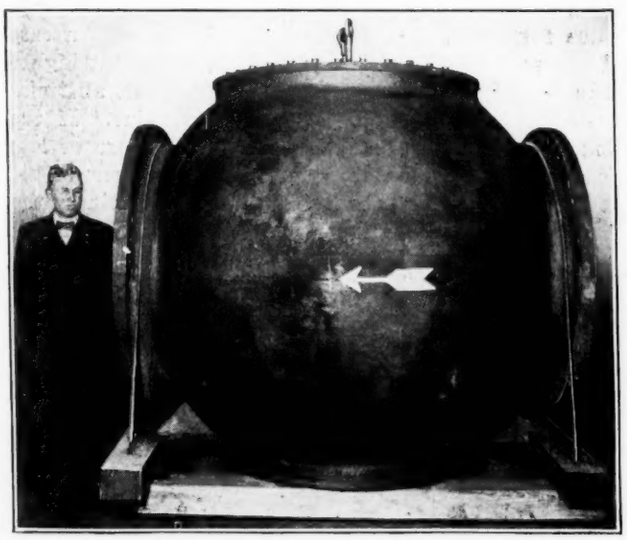
When the remaining four condensers are installed, they will receive circulating water through tunnels running from the crib to the intakes of their circulating pumps. Each circulating-pump intake pipe is provided with an extra-heavy sluice gate, Fig. 3, operated by a hydraulic

cylinder for controlling the flow of water to the pumps. The general station arrangement permits the screens in the crib to be handled by the 110-ton turbine-room crane, which is provided with a 15-ton auxiliary hoist. The traveling screens are mounted in a vertical position and are so arranged that they can be raised or lowered.

Figures regarding the construction of the tunnels and condenser pit are of interest. The intake and the discharge tunnels from the river to the intake in the station building required approximately 30,000 cu.yd. of excavation, 5300 cu.yd. of concrete and 270 tons of reinforcing. The condensing pit, which is 25 ft. 6 in. wide, 91 ft. long inside and 74 ft. deep, required approximately 32,000 cu.yd. of excavation, 13,500 cu.yd. of concrete placed and 514 tons of reinforcing steel, as well as 315 tons of structural steel used in the construction.

A Forty-Eight-Inch Relief Valve

There has recently been built one of the largest relief valves ever manufactured, for the Conners Creek plant of the Detroit Edison Co. It is a 48-in. horizontal exhaust relief valve, and is hydraulically operated. It will serve as a safety relief for the condenser on a new turbine unit. The complete valve weighs 14,000 lb. and measures 7 ft. 5 in. from face to face of the flanges. The cast-iron valve disk is 48 in. in diameter and has a



A 48-IN. EXHAUST RELIEF VALVE

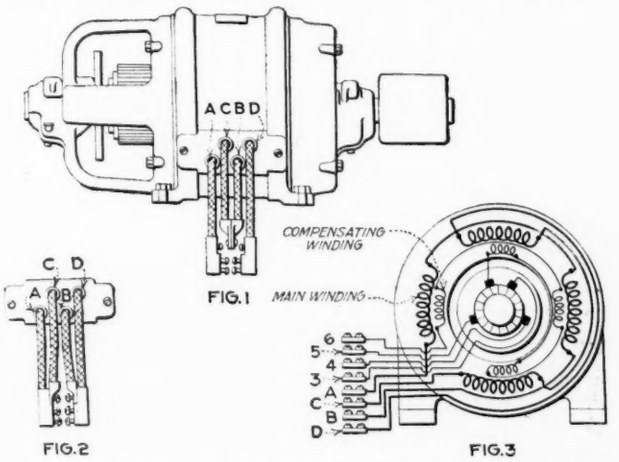
metal ring face which seats on a brass ring. It is water-sealed and is double-cushioned with brass-lined dashpots above and below the disk. The valve stem is 3½ in. in diameter. The illustration gives an idea of the relative size of the valve; it was built by the G. M. Davis Regulator Co., Chicago, Ill.

Variable-Speed Motor Used in Constant-Speed Service

By E. C. Parham

Repulsion-induction motors of the constant-speed type have four leads coming from the stator winding, as in Fig. 1. If the supply voltage is 220, the two short leads are connected together as in the figure, thereby connecting the two sections of the stator winding in series. If the supply voltage is 110, then each short lead is connected to a long lead, as in Fig. 2. This connects the two sections of stator winding in parallel.

In some types of repulsion-induction motors they are equipped with a set of energy brushes and a set of com-



FIGS. 1 TO 3. ARRANGEMENT OF LEADS FROM A REPULSION-INDUCTION MOTOR

Figs. 1 and 2—Constant-speed motor. Fig. 3—Variable-speed motor.

pensating brushes on the commutator. Inside of the motor frame the two energy brushes are connected together and the two compensating brushes are connected to the compensating field winding. Where such a motor is to be used on variable-speed duty, the energy and compensating circuits are opened and the ends appear at the outside of the motor as two more pairs of leads that are to be connected to the controller by means of which the speed is varied by varying the amount of resistance included in the energy and compensating-field circuits. Where such a motor is to be used on constant-speed duty, no controller is required and the two energy-brush leads are connected together, also the compensating leads, the stator leads being grouped according to the voltage and connected to the starting switch.

A second-hand repulsion induction motor was bought and applied to the driving of a pump through a worm and gear. The motor was complained of because it could not be started. What puzzled the local electrician was that the motor had eight leads and the starting switch had connections for only two wires coming from the motor. Investigation developed that the motor formerly had been used on variable-speed duty and it now was to be used in constant-speed service.

The leads of the energy brush-holders always are tagged 3 and 4 and those of the compensating brush-holders, 5 and 6 as in Fig. 3; and in this particular case the tags were still in place. By lifting the brushes, so that the holders would not be connected together through the armature, and testing, the energy leads 3 and 4 were identified and connected together, also the compensating leads 5 and 6 were found and joined. The stator leads were easily identified because each short lead was connected to the long lead nearest to it, showing that the motor formerly had been operated on a 110-volt circuit. As the work in hand called for 220-volt operation, the short leads were disconnected from the long ones and connected together, as in Fig. 1, and the two long leads connected to the motor side of the starting switch. On closing the switch, the motor started promptly, and it gave no further trouble.

Measuring High Pressures With Dead Weight

By SANFORD A. MOSS
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Complete details are given for using the equivalent of the dead-weight pressure-gage tester for measuring pressures during tests as used in the steam-turbine department of the General Electric Co., Lynn, Mass.

EVERYONE who has had any experience with the use of Bourdon pressure gages, even of good quality, knows that they are more or less troublesome when extreme accuracy is desired. Frequently the calibrations before and after the test disagree.

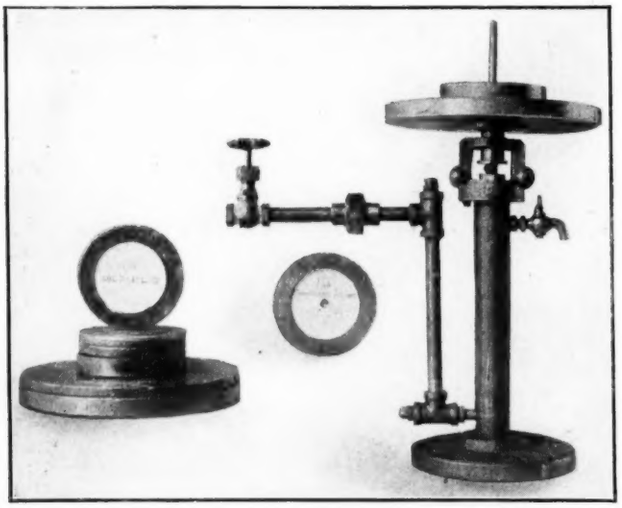


FIG. 1. DEAD-WEIGHT PRESSURE GAGE

Even if the calibrations do agree, there is often a question as to whether the temperature effect has been properly taken care of. Most Bourdon gages are not accurate to a per cent., therefore, they are usually read to one per cent. by estimation between graduations. Accuracy of the construction probably does not warrant closer graduation than the coarse one usually given.

The dead-weight pressure gage consists of an accurately bored cylinder, usually having an area of one-eighth of a square inch, with a closely fitting piston, at the top of which is a platform on which are placed weights sufficient to keep the gage floating. The instrument in this form has been in use for many years for testing pressure gages. For use in direct measurement of pressure, the addition of a stop must be made to prevent the piston from rising out of the cylinder, and an oil trap and reservoir so that there is sure to be oil in contact with the cylinder and piston. The construction can also be cheapened from that usually adopted in dead-weight testers. The platform and piston must always be spun by hand when the apparatus is in use.

The use of a dead-weight apparatus thus attached directly to the pipe where pressure is being measured, gives accuracy to within about 0.25 of one per cent. without any difficulty whatever. The dead-weight apparatus is cheaply and easily made and easily operated. Considerable experience indicates that it is satisfactory in every way. Fig. 1 shows the apparatus used in the turbine department of the General Electric Co.'s Lynn works, where there are about fifteen outfits, all in more or less regular use. This system has been in use in this department for over ten years. Fig. 2 indicates the manner of installation, operation and a machine on test. Fig. 3 gives a sectional view of the apparatus.

The apparatus is primarily adapted for testing work where the pressure is constant or nearly constant and where the exact value, whatever it may be, must be known at frequent intervals, or where an exact value must be held by hand regulation. Following are some tests in which dead-weight gages have been used.

A. Laboratory test of a steam turbine, or the like, at a given load point such as full-load, half-load, etc. Steam pressure is held by hand regulation at an exact value for which the turbine is rated. In such a case of course the boiler pressure must be somewhat higher than the rated pressure and an attendant at all times holds the pressure at the exact rated value. If the Bourdon gage were used, there would be more or less uncertainty about the pressure due to variations of the boiler pressure or governing of the turbine; the throttle valve is being opened or closed slightly at all times during the test. The Bourdon gage, for pressures

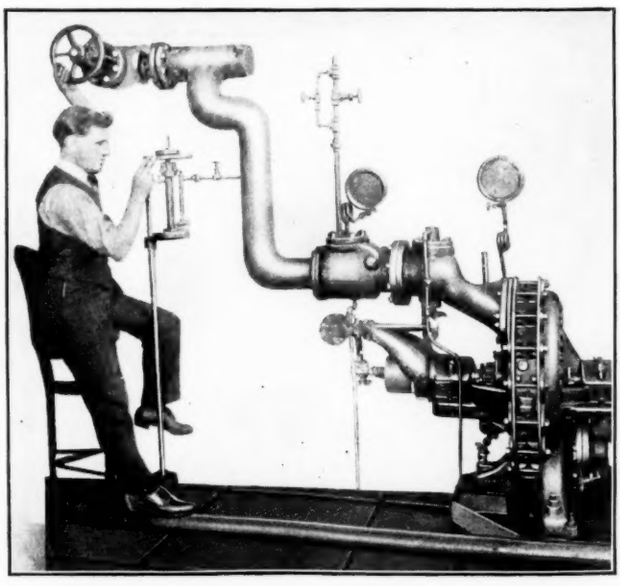


FIG. 2. DEAD-WEIGHT GAGE INSTALLED ON TURBINE

that vary, gives an appreciable difference. On the contrary, with a dead-weight gage, the attendant, after ten or fifteen minutes' practice, can hold the rated pressure within 0.25 of one per cent. or less. In such a tes.

the load, which is an electric generator, is either held exactly constant by hand regulation of water rheostats or the like, or else is set at nearly desired value and allowed to drift up and down near the correct value. If the load or steam pressure varies rapidly, the dead-weight pressure gage cannot be used.

B. Calibration of steam-turbine nozzles or other work on flow of steam, or high-pressure air through orifices. Here there is a constant opening through which a fluid is discharged, and a constant pressure is to be held by hand regulation of a throttle valve just as in the preceding case. The steam is of course condensed and weighted at successive intervals. The flows during each interval should be all alike. Much greater precision is secured in this particular with a dead-weight gage than with a spring-pressure gage.

C. Test of any other type of steam or high-pressure air machinery where an exact pressure is to be held by hand regulation at all times during the test.

D. Test of a high-pressure centrifugal pump. Here a dead-weight gage can be used with great satisfaction to measure the discharge pressure. If the volume flowing is measured by means of orifices, another dead-weight gage can be used to measure the orifice pressure.

E. Test of a high-pressure air compressor. If the compressor is a reciprocating machine, there must be the usual air receiver with capacity enough to smooth out the pressure fluctuations so that the dead-weight gage will give the average value. Here also, if the air-compressor flow is being measured by means of an orifice, a dead-weight gage can be used to give orifice pressure. If the flow of the reciprocating compressor is being measured, the arrangement of the orifice must be especially attended to. There must be a large receiver, and a throttle valve between discharge pressure and orifice pressure so as to reduce the orifice pressure a very considerable amount. This throttling smooths out the flow so that the pressure is not pulsating at the orifice. As is well known, the average value of a pulsating orifice pressure does not give the average flow. If the orifice can be made large enough, it is best to reduce the orifice pressure by throttling until it is about 15 lb. per sq.in. Then the orifice dead-weight gage could be discarded altogether and a mercury column used.

In orifice tests of pumps or air compressors, as in D or E it is necessary to have two dead-weight gages or one dead-weight gage and one mercury column, since there are two distinct pressures. One of these is a discharge pressure measured in the pipe between the throttle valve and the machine and gives the pressure with which the machine is to be credited in computing its performance, efficiency, etc. The throttle valve cuts down this pressure so that any desired pressure can be had on the orifice so as to give any desired volume or amount of flow, which is computed from the orifice pressure. This orifice pressure may be measured by means of a static hole in the pipe wall with a pipe connecting to the dead-weight gage or mercury column, or an impact tube may be used in the jet discharged from the orifice as explained in the paper, "The Impact Tube," A. S. M. E. *Transactions*, December, 1916.

F. Measurement of high pressures during any experimental work such as hydraulic work, high-pressure steam work, or the like, or calibration of thermometers by means of high-pressure steam. The dead-weight gage of the construction here described has been successfully used for pressures up to 500 lb. per sq.in. without any difficulty. For very high pressures, pistons of larger diameter, as well as lever devices for balancing the piston, have been proposed. Just how far the one-eighth-inch piston with direct balancing can be used, and the magnitude of the pressure when it is necessary to resort to other devices, cannot be definitely stated.

During use of the dead-weight gage in any test such as the preceding ones, if the pressure variation is such as to require constant adjustment by an attendant, there must be provided a throttle valve at a convenient location and the gage must be piped near-by. The attendant

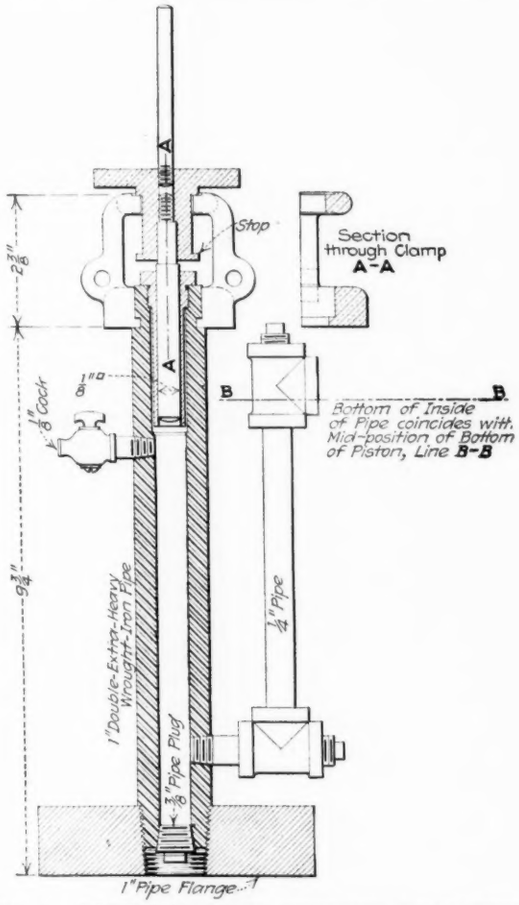


FIG. 3. SECTIONAL VIEW THROUGH DEAD-WEIGHT PRESSURE GAGE

then has one hand on the throttle valve and with the other hand spins the dead-weight gage, as in Fig. 2. He turns the throttle valve backward and forward so as to keep the gage floating between the top and bottom stops. After about ten minutes' practice anyone, even an unskilled laborer, can keep the gage floating without any difficulty whatever.

In some tests the pressure does not vary much, so that no hand regulation is required. In such cases, whenever a pressure reading is needed it must be taken by adding or subtracting one-pound weights until the gage floats. During all periods when reading of the gage is being observed, it must be spun by hand. For this reason it is an advantage to have the heavier weights thin and of large diameter rather than thick and of small diameter, so that a single spin will persist for a long period.

The valve used to regulate the pressure which is read by dead-weight gage must be adapted to that purpose. If the valve is too large, the motion is so small as to be difficult. If it is too small, the motion is too large. The easiest way of handling this matter is to have two throttle valves in the line. One of these is set at such a point as to give easy manipulation of the second one, which is thereafter the one regulated to keep the gage floating.

TABLE I. WEIGHTS TO GIVE ABSOLUTE PRESSURES FOR VARIOUS BAROMETER READINGS

Uncorrected Barometer Reading Inches of Mercury	Temperature of Mercury, Degrees F.								
	60	65	70	75	80	85	90	95	100
28.5	6.05	6.05	6.05	6.05	6.05	6.10	6.10	6.10	6.10
28.6	6.00	6.00	6.00	6.00	6.00	6.05	6.05	6.05	6.05
28.7	5.95	5.95	5.95	5.95	5.95	6.00	6.00	6.00	6.00
28.8	5.90	5.90	5.90	5.90	5.90	5.95	5.95	5.95	5.95
28.9	5.85	5.85	5.85	5.85	5.85	5.90	5.90	5.90	5.90
29.0	5.80	5.80	5.80	5.80	5.80	5.85	5.85	5.85	5.85
29.1	5.75	5.75	5.75	5.75	5.75	5.80	5.80	5.80	5.80
29.2	5.70	5.70	5.70	5.70	5.70	5.75	5.75	5.75	5.75
29.3	5.65	5.65	5.65	5.65	5.65	5.70	5.70	5.70	5.70
29.4	5.60	5.60	5.60	5.60	5.60	5.65	5.65	5.65	5.65
29.5	5.55	5.55	5.55	5.55	5.55	5.60	5.60	5.60	5.60
29.6	5.50	5.50	5.50	5.50	5.50	5.55	5.55	5.55	5.55
29.7	5.45	5.45	5.45	5.45	5.45	5.50	5.50	5.50	5.50
29.8	5.40	5.40	5.40	5.40	5.40	5.45	5.45	5.45	5.45
29.9	5.35	5.35	5.35	5.35	5.35	5.40	5.40	5.40	5.40
30.0	5.30	5.30	5.30	5.30	5.30	5.35	5.35	5.35	5.35
30.1	5.25	5.25	5.25	5.25	5.25	5.30	5.30	5.30	5.30
30.2	5.20	5.20	5.20	5.20	5.20	5.25	5.25	5.25	5.25
30.3	5.15	5.15	5.15	5.15	5.15	5.20	5.20	5.20	5.20
30.4	5.10	5.10	5.10	5.10	5.10	5.15	5.15	5.15	5.15
30.5	5.05	5.05	5.05	5.05	5.05	5.10	5.10	5.10	5.10
30.6	5.00	5.00	5.00	5.00	5.00	5.05	5.05	5.05	5.05
30.7	4.95	4.95	4.95	4.95	4.95	5.00	5.00	5.00	5.00
30.8	4.90	4.90	4.90	4.90	4.90	4.95	4.95	4.95	4.95
30.9	4.85	4.85	4.85	4.85	4.85	4.90	4.90	4.90	4.90
31.0	4.80	4.80	4.80	4.80	4.80	4.85	4.85	4.85	4.85

As seen in the figures, the dead-weight gage is connected so that there is a "U" of oil with the piston at the top of one leg and the applied pressure at the top of the other. The pipe from the latter point must be led downward to the place where the pressure is being measured, so there will be no chance of a water trap giving error. The point from which the pipe is led downward must be nearly on a level with the average position of the bottom of the piston, so as to automatically maintain the liquid level the same in the two sides of the "U."

If the gage is filled with oil at the beginning of a test, there is usually not enough oil leakage to require any refilling. The gage was originally filled by removing the stop casting and lifting the piston out of the cylinder. However, with the piping arrangement shown in the figures, removal of the stop casting and piston is avoided as follows: The two plugs in the tees at the top and bottom of the side-pipe leg are removed and the vent cock opened. After the water has run out, the bottom plug is inserted and oil added at the top opening.

In air tests, a slight oil leakage during the test gives an error of a head of oil equal to an inch or so. In steam tests the gage oil is replaced by water so that the error will only be that due to the difference between an inch or so of oil and an equal amount of water. As in all pressure measurements, the pipe connecting the dead-weight gage to the place where pressure is being measured, must be absolutely tight. This pipe is usually ¼-in. standard material. However, if there is any appreciable length of pipe, it should be made ½ inch.

Any dead-weight gage tester can be used as a dead-weight gage by arranging a stop so that the piston cannot be ejected from the cylinder. However, the gages on the market are of more expensive construction than is desirable for ordinary pressure-measuring purposes, so that home-made ones similar to that shown in Fig. 3 must be used, until some manufacturer produces a gage whose cost is considerably less than that of the present types on the market. The gage shown was made by purchasing pistons and cylinders from a manufacturer, which were made with the precision necessary for this work. A stop was fastened to the piston and holes bored in the platform so as to leave the weight the same as before. The weights were carefully made by use of a precision scale, so as to weigh within 0.1 of one per cent. of the correct amount. The pressure in pounds per square inch for each weight is of course eight times that of the weight in pounds.

In the course of comparative tests with a given machine on different days, if the same dead-weight gage pressure is held, the absolute pressure will vary. For accurate work this is avoided by use of a set of barometer weights. These vary from 4.85 to 6.05 lb. per sq.in. by 0.05 lb. and are selected according to the barometer so as to give the same absolute pressure each day, as per Table I.

The first column of the table (as well as Table II) gives the actual reading of the mercury column of the barometer without correction for mercury temperature. The headings of the other columns give various values of the temperature of the mercury column of the barometer, and the body of the table gives that one of the barometer weights which is to be added on the gage. The other weights to be used must total the desired absolute pressure minus 20; that is, the weight placed on the gage should be the desired absolute pressure in pounds per square inch, minus 20, plus weight in table.

TABLE II. INCHES OF WATER TO GIVE 15 LB. PER SQ.IN ABSOLUTE EXHAUST PRESSURE

Uncorrected Barometer Reading Inches of Mercury	Temperature of Mercury, Degrees F.								
	60	65	70	75	80	85	90	95	100
29.0	21.9	22.1	22.3	22.5	22.6	22.9	23.0	23.1	23.4
29.1	20.5	20.7	20.9	21.1	21.2	21.5	21.6	21.8	22.0
29.2	19.2	19.3	19.6	19.7	19.9	20.1	20.3	20.4	20.7
29.3	17.8	18.1	18.2	18.4	18.5	18.8	18.9	19.0	19.3
29.4	16.5	16.7	16.8	17.0	17.3	17.4	17.5	17.8	18.0
29.5	15.1	15.4	15.5	15.6	15.9	16.1	16.2	16.5	16.6
29.6	13.7	14.0	14.1	14.3	14.6	14.7	14.8	15.1	15.2
29.7	12.4	12.6	12.8	12.9	13.2	13.3	13.5	13.7	13.9
29.8	11.0	11.3	11.4	11.7	11.8	12.0	12.2	12.4	12.5
29.9	9.7	9.9	10.1	10.3	10.5	10.6	10.9	11.0	11.2
30.0	8.3	8.6	8.7	9.0	9.1	9.3	9.5	9.7	9.8
30.1	6.9	7.2	7.3	7.6	7.8	7.9	8.2	8.3	8.4
30.2	5.6	5.8	6.0	6.3	6.4	6.5	6.8	6.9	7.1
30.3	4.4	4.5	4.6	4.9	5.0	5.2	5.4	5.6	5.7
30.4	3.0	3.1	3.3	3.5	3.7	3.8	4.1	4.2	4.5
30.5	1.6	1.8	1.9	2.2	2.3	2.4	2.7	2.9	3.1
30.6	0.3	0.4	0.5	0.8	1.0	1.1	1.4	1.5	1.8
30.7	—1.1	—1.0	—0.8	—0.5	—0.4	—0.3	0.0	0.1	0.4
30.8	—2.4	—2.3	—2.2	—1.9	—1.8	—1.6	—1.4	—1.2	—1.0
30.9	—3.8	—3.7	—3.5	—3.3	—3.1	—3.0	—2.7	—2.6	—2.3
31.0	—5.1	—5.0	—4.9	—4.6	—4.5	—4.4	—4.1	—3.9	—3.7

Fifteen pounds per sq.in. equals 30.35 in. of mercury; 1 in. of mercury equals 13.6 in. of water.

Change of barometer also affects the absolute exhaust pressure in comparative tests made on different days of a noncondensing steam turbine or the like. Although this point has nothing to do with dead-weight gages, a method of handling the absolute exhaust pressure will be given. This is to always hold such back pressure on the exhaust line as will give exactly 15 lb. absolute pressure. This is accomplished by putting a water U-tube on the exhaust line and throttling the exhaust until the back pressure indicated by the U-tube plus the reading of the barometer is such as to give the desired absolute pressure. Table II gives the inches of water to be held in the U-tube to secure this effect, taking into account the temperature of the barometer column.

Some Why's of the Coal Shortage

There have been many assertions as to the cause of the prevailing coal shortage in that those interested in the production, transportation, handling at the terminals and in the delivery to the coalyards claim that the trouble has been due to the failure of some other arm of the coal-handling organization. Some of the causes for the scarcity of coal are enumerated in this article.

IT HAS been asserted almost countless times that the American public do not realize that we are at war. This may have been true to a great extent prior to Jan. 16, when, by the order of Dr. Harry A. Garfield, Fuel Administrator, practically all of the industries east of the Mississippi River were closed for a period of five days and by which order, countermanded now, Mondays were to be workless until Mar. 30; but the assumption does not now apply. The five worklessdays bomb was an effective awakener for the American people to the fact that war does exist. Furthermore, the average citizen knows more about the coal situation today than he ever did before the closing-down order went into effect.

Shortage Traceable as Far Back as July

That there is and has been a serious shortage of coal, both for domestic and manufacturing purposes, is without question a fact. Thousands of individuals have their belief as to the cause, and they are varied. It is evident to many that the coal shortage does not date back to the extreme cold weather of the past few weeks, but rather that it is traceable as far back as July of 1917.

Previous to this date the coal operators had reduced their rates from $5 and $6 to $3 per ton, and a few days later the Secretary of War reduced the price to $2.50 a ton for all coal sold to the Government. Those who thought they were foresighted and who were accustomed to put in winter coal during the summer months held off with the idea that a better price would obtain later on. The result was that the movement of coal during the summer months was greatly retarded because consumers delayed their buying, and the possibilities are that orders for thousands of tons of coal were cancelled. It is easy enough now to see that this was a mistake and that this coal should have been purchased and delivered before the cold weather came to delay traffic and freeze the coal in the cars, which so seriously delays the unloading. Naturally, the time lost because of the public waiting for a lower price could not be made up after the price of coal was fixed at $2 a ton, during the latter part of August, and which was later found too low and increased to $2.45.

Has price fixing saved the public money? This is a debatable question. One thing is certain—there has been a loss to the country in the extra coal produced because the price fixed by the Government is for run-of-mine coal and the added tonnage mined is largely slate and refuse. That some of the coal operators have no scruples about putting their hands in the pockets of those who cannot afford to spend an extra nickel for coal is evident when they ship trash that is being sold for fuel at a price that is high for a good grade of coal.

There was produced 642,340,134 short tons of coal in 1917. This coal in normal times should run not higher than 8 per cent. ash, but much of it is running as high as 18 per cent. at the present time and some of it as high as 35 per cent. It is safe to assume that there is at least 6 per cent. more ash included in the total coal shipped to consumers last year than in the year previous, which if true would mean that 38,540,408 tons of last year's coal output is in the form of increased ash and bone. Taking an average of 45 tons per car, this would mean that 856,453 carloads of ash is being added to the transportation difficulties of the railroads. At 60 loaded cars per train there would be required 14,274 locomotives to move this material that has no heating value.

Efficiency of Fuel Decreased

This useless transportation of noncombustibles does not stop with the delivery of the cars at their destination. It has been determined by experiments conducted by the Bureau of Mines, that there is a decrease of approximately 1.5 per cent. in efficiency for each 1 per cent. additional ash contents to the coal, and an increase of 6 per cent. in ash content over normal conditions means that the efficiency of the coal is reduced about 9 per cent., which, plus 6 per cent. additional ash in the coal now being sent to the consumer, makes a 15 per cent. reduction in the efficiency of the fuel.

It would seem, then, that although more fuel was shipped from the mines last year than during the previous year, there is an actual decrease in the effective coal received by the consumer. This is certainly a matter that the Fuel Administration at Washington should take in hand. The writer has seen coal that looked fully 40 per cent. slate and incombustible, which is being sold to the consumer. Selling such coal at the prevailing prices makes the offense of stealing pennies from a dead man's eyes look like a virtue in comparison.

The Railroads Said To Be at Fault

The tying up of 14,000 locomotives in hauling as many trains of 60 loaded cars of ash is one of the several reasons for the present fuel shortage. More than one man occupying a responsible position asserts, and with apparent justification, that the railroads are at fault in that they have failed to render the full measure of car service of which they have been capable, and some believe that this has been done deliberately to make it appear that the recent demands for higher freight rates were justifiable.

It has also been claimed that for every period of decline in coal production since the United States entered the war figures show that the railroads were rendering less car service than in the corresponding weeks or months of the preceding year, and furthermore, that there has been misuse and nonuse of available cars. That is, if the empty cars had been shipped back to the mines as soon as they were unloaded instead of be-

ing held on side tracks, there would have been enough cars to move all the coal required both by the manufacturers and by the public at large. The coal shortage is reported as being approximately 10 per cent. of the requirements, and it is also claimed that the railroads' performance is about 10 per cent. less than it was in 1916.

Inefficiency on the part of the roads is also charged, and this applies to the repairing of motive power, the lack of which is one of the principal causes for the freight congestion at various points of the railroad systems. The demand for locomotives is so great that only such repairs as are absolutely necessary are made, and minor repairs, such as would increase their efficiency, are left undone.

Condition of Equipment Below Normal

That the railroads have neglected to maintain their equipment at normal is shown in the orders they have issued from new locomotives during the last year. The following figures regarding this feature of the railroad difficulties are of interest: A total of 3467 locomotives were ordered by the American railroads in 1913, 1262 in 1914, 1612 in 1915, 2910 in 1916 and 2704 in 1917, an average of 2391 per year during the past five years. In 1905 there were 6255 locomotives ordered for use in the United States. At least 5000 new locomotives, it is estimated, are needed each year by the railroads of the United States. Foreign orders for 1916 totaled 2983, and in 1917 there were ordered by our Allies 4938 locomotives, of which 2057 were for the use of the United States in France. The actual deliveries to our railroads were 5332 locomotives in 1913, 1251 in 1915, 2708 in 1916 and 2587 in 1917. The deliveries to foreign countries were 2861 in 1917. As the railroads of the United States have for the last three or four years ordered but a little more than half the number of locomotives required to move the tonnage consigned to them, there is little cause for speculation as to why they have fallen down in their attempt to move freight and do away with congestion that appears to block the freight yards throughout the country.

Increase in Car Mileage and Tonnage Handled

On the other hand, railroad statistics for 1917 show that the average car mileage per day was 27.7, as against 27.5 for 1916, and that there was 18 per cent. increase in the coal tonnage handled in 1917 over 1916. Railroad officials claim that they can deliver to terminal points only such coal as is consigned to them and that they do not control the acts of the shipper. As an example, one railroad had one day recently 600 steel cars of 50 tons capacity each, or sufficient to carry 30,000 tons of coal, distributed at the anthracite mines that it serves. When these cars were loaded, they went in all directions—not as the railroad's manager chose, but as the shippers directed.

That something is radically wrong is self-evident, and some of the trouble that has resulted in a gigantic freight jam may be due to a cause similar to that recently published in the Boston *News Bureau:*

> A. R. Whaley, former operating vice president of the New Haven, recently inspected the congestion in the Jersey terminals and was discussing it with the yardmaster, an old-time railroad man.
>
> "What is the basic trouble?" asked Whaley. "We used to handle things better."
>
> "I'll tell you," said the yardmaster. "Twenty-five years ago, when you and I started, they had wooden cars, but they had men of steel handling them. Nowadays, they've got steel cars, but there's a blamed lot of wooden men handling them."

Snow and extreme cold weather have contributed to the coal shortage by delaying rail transportation and the unloading of the frozen coal from cars into barges for water transportation.

New England, as well as New York and other Eastern cities, is a sufferer. In Boston about 90 per cent. of the 45 coalyards are bare of fuel. The railroads have been unable to increase their shipments, and but little coal has been coming in by water.

Among other things that contribute to this condition is the order that was given earlier in the season to ship coal to the Northwest, with the result that it could not be absorbed and thousands of loaded coal cars have been standing on the tracks between the mine and the West; this is one cause of car shortage. The condition is traceable back to the fixing of prices of coal and the uncertainty of getting it. Much of the trouble that New England is experiencing is due, it is believed, to the holding up of coal shipments during several weeks during the summer months and fall, in the endeavor to obtain lower rates to the tune of one dollar per ton.

New England uses approximately 25,000,000 tons of coal per year, most of which comes from the Virginia coal mines. This year there was required about 7,000,000 tons more.

Another reason why New England is out of coal is because the Government commandeered five of the thirty-five collieries that brought coal to that section and also took over seven out of forty-five tugs that were used in towing from two to four coal barges at a time. As a matter of fact, then, there has been 1,000,000 tons less of coal brought to New England by water, and on the other hand the roads have brought in about 1,000,000 tons more than usual.

The coal-mine operators claim that the coal shortage is due to lack of cars. They maintain that it is idle to talk of increasing the output of the mines until the cars are available to transport it. They claim that the coal production could be greatly increased if there were cars in which to load it. It is pointed out that on the average 200,000 coal miners are idle each day in the year because the output cannot be handled by the railroads; that there has been no falling down in the production of coal at the mines, but that the trouble is due to distribution.

Loss of coal output can be easily traced to the method of shipping, whereby coal going to one section passes coal going in the opposite direction. That is, it is a waste of mileage, locomotives and car haulage to ship coal to a consumer, say 400 miles or so from the mines, when coal could be obtained in a mine not more than 200 miles distant. This method of distribution has been carried on unchecked and has undoubtedly cost the nation thousands of dollars. Recently, S. Peabody advocated before the Senate Investigation Committee a zone system dividing the country into thirty distinct districts, and he stated that it would increase the country's output of coal by 20 per cent. Under such a system no coal would be sent out of one zone into another without a license from the Fuel Administration.

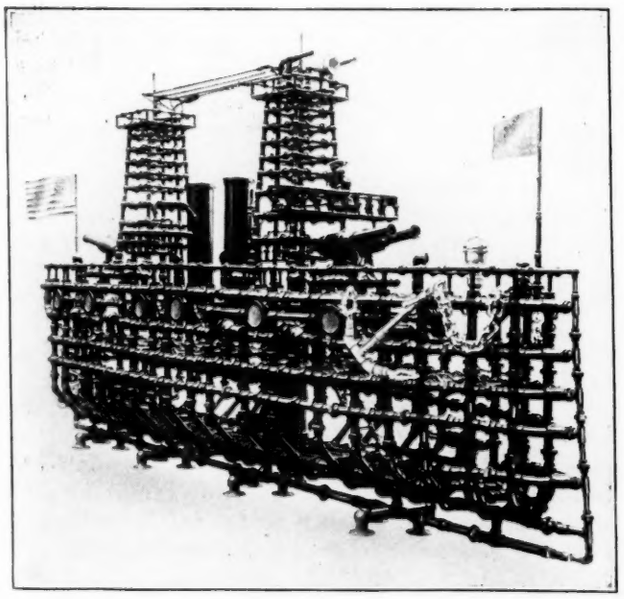
That there will be a scarcity of coal during the rest of the winter and well on into the spring is a foregone conclusion. What the situation will be after that is problematic. Conditions will doubtless change for the better to some extent, but it will be impossible to get coal in large quantities. That a repetition of present conditions shall not prevail next winter a number of changes in the handling of coal should be made.

The householders should order coal during the summer months. The coal operators should be made to sell clean coal, not adulterated with ash and bone. The unloading piers should be equipped with suitable means for thawing frozen coal in cars. The railroads should repair their locomotives and order new ones so that their motive power can handle the volume of freight that must reach the points of delivery. Empty cars should be moved to the mines as fast as they are emptied, and the fuel and railroad administrators should work together to bring such changes about.

New England should be taken care of by seeing to it that sufficient bottoms are available for transporting coal by water and thus avoid their present predicament.

Model of Superdreadnaught "New York"

The illustration gives a view of a model of the superdreadnaught "New York," made completely of Crane Co. products—fittings, valves, specialties, etc. According to the *Valve World*, the model was designed and its



MODEL MADE OF FITTINGS

construction supervised by an employee of Crane Co. in the works of the company's Bridgeport division. It is now on exhibition in the Crane exhibit rooms, 23 West 44th St., New York.

The over-all dimensions of the model are: Length, 186 in.; breadth, 34 in.; molded depth, 42 in., total height from keel to topmast, 102 in. Its net weight is 3308 lb., and 6669 separate pieces were used in its construction. It is complete to the smallest detail, and the ordinary working parts of a battleship are movable. A small electric motor gives action to the propeller. The ship is electrically wired throughout, the wires running in conduit, and by the pressing of a button action may be seen everywhere—the propeller turns, the commander salutes, lights flash, guns roar, the wireless crackles, the searchlight throws a searching beam. The entire action is automatic and may be repeated indefinitely or until the pressing of another button stops it. A row of colored electric lights runs from bow to stern over the mast tops, and when in action the model makes an interesting exhibition.

Eleven Ohms the Resistance of a Circular-Mil-Foot

BY T. A. NASH

The resistance of a circular-mil-foot of copper depends on the purity of the copper and on its temperature. The resistance of ordinary commercial soft-drawn copper wire at 70 deg. F. is almost exactly 10.6 ohms. However, the use of the value of 11 ohms in the formula for a two-wire circuit,

$$cir.\ mils = amperes \times 11 \times total\ length\ of\ conductor\ in\ feet \div volts\ drop,$$

is justified. In computing wire sizes for interior-wiring circuits, it is folly to endeavor to figure too closely. The length of the circuit is probably not known within 10 per cent., the purity of the copper to be used is unknown, and finally, one must use conductors of one of the standard wire-gage sizes. Hence, it is common practice to use the 11-ohms value in practical calculations because the results obtained by using it will, on the average, be as accurate as those obtained by using 10.6 ohms, and it (11 ohms) is an easier figure to handle. Also the value 11 ohms can be remembered easily.

Inexperienced Draymen Damage Heavy Machinery

A recent purchaser of a large air compressor points out that irresponsible draying firms cost the purchaser of heavy machinery far more than is saved by patronizing inexperienced firms who will take a job "for less." The point is that serious damage can be easily done by inexperienced teamsters in delivering heavy machinery from railroad depot to plant and it may be that this damage will not be discovered until the plant is being tested in operation. In that case the blame may never be properly placed and is very likely to be charged up to the manufacturer as a defect in construction. The case in point occurred recently in a Western city. Some large-sized compressors were hauled across the town in such a position on the dray that the stress of shocks from the wheels was carried by bolts in the lining of the cylinder, which separated the water jacket from the compressor chamber, and these stresses so strained the bolts that a joint was opened and leakage resulted that caused much delay and inconvenience after the unit had been put in operation. In this instance a capable mechanical engineer saw the compressor in its strained position on the dray and at once entered a protest, predicting the possibility of the trouble which, in fact, later developed.

Mine Plant Saves Forty-Five Tons of Coal Per Day

Installation of a new boiler plant, utilization of exhaust steam by a low-pressure turbine and a change from steam and compressed air to electric drive for auxiliaries and mine pumps resulted in a reduction of fuel of from 90 to 45 tons per day. Besides, the mine capacity per day was increased 50 per cent.

ABOUT two years ago the Chicago & Carterville Coal Co. decided to improve its power plant at Mine A, at Herrin, Ill. The plant at that time consisted of eight horizontal-tubular boilers 72 in. diameter by 18 ft. long, one 250-hp. and one 350-hp. water-tube boilers, each being equipped with an independent steel stack. The equipment supplied by the boilers consisted of one 250-hp. and one 450-hp. air compressors and also one 170-kw. electric generating unit. Standard steam piping with screwed fittings was used.

All the auxiliaries around the mine, consisting of the coal washer, the centrifugal pump for the washer, the shaker engine, the engine for driving the shop, the main fan and various other small units, were steam-driven. The steam lines were run underground in many cases with no insulation. Most of the joints were leaking, and the entire plant was in a deplorable condition, being extremely wasteful in the use of steam. Under these conditions it required 90 tons of coal per day to operate the plant, nine firemen for the three shifts and three ash wheelers. No. 4 washed coal was burned under the boilers.

After a careful examination it was decided to install a new boiler plant, consisting of water-tube boilers equipped with chain-grate stokers, and a 500-kw. mixed-pressure turbine to utilize the exhaust steam from the present air compressors and fan engine. Provision was made also for using, at some future date, the steam from the main hoisting engine by the use of a regenerator. There was no need to draw on the hoisting engine for the time being, as the two compressors would furnish more than enough exhaust steam to operate the low-pressure turbine at full load.

Steam Drive Replaced by Electric

All the steam-driven auxiliaries were to be replaced by electric-driven units with the exception of the engine driving the main fan. Distributed at various points about the mine were several pumps that had been operated by compressed air taken from the main air lines in the mine, supplying the punchers used for undercutting the coal. These pumps were extremely wasteful in the use of compressed air, and it was decided to replace them with direct-connected centrifugal pumps, and in a few cases where gathering pumps would be required of a portable type, with motor-driven reciprocating pumps.

On account of the scarcity of water for condensing purposes, it was decided to install a spray pond, the makeup water being drawn through a 4-in. line from a small pond about a quarter of a mile distant by a motor-driven pump. The plant had been operating on city water, as the water available close to the mine was too poor in quality to use in the boilers. The new arrangement provided for a vertical motor-driven submerged centrifugal pump placed at one corner of the spray pond, which delivers the water direct to the feedwater heater.

The new boiler plant consists of three 350-hp. water-tube boilers, two being new and the third a boiler from the old plant. All are provided with chain grates and are connected to a 7 x 210-ft. concrete stack, the stack and breeching being arranged for the installation of an additional boiler at some future time.

Punchers Used To Undercut Coal

As previously stated, the present method of undercutting coal is by the use of punchers driven by air furnished by the two compressors now supplying exhaust steam to the low-pressure turbine. It is the intention, however, at some future time to do the undercutting with electrically operated machines. When this is done, the two compressors will be abandoned and steam for operating the low-pressure turbine will be obtained from the hoisting engine, the engine driving the 170-kw. generator and the mine fan engine. As the turbine is of the mixed-pressure type, it may be operated on live steam at periods when insufficient exhaust steam is available. The turbine drives a 500-kw. 250-volt direct-current compound-wound generator through reducing gears, the reduction being from 3600 to 720 revolutions per minute.

The condensing equipment consists of a Rees Returbo installation taking water from the spray pond and returning it through 60 nozzles. It is capable of producing 28 in. of vacuum, referred to a 30-in. barometer, the year around and a great part of the year produces a vacuum of 29 in. and better. The condenser is driven through gears by a steam turbine, and the exhaust steam is delivered to the 500-kw. low-pressure unit.

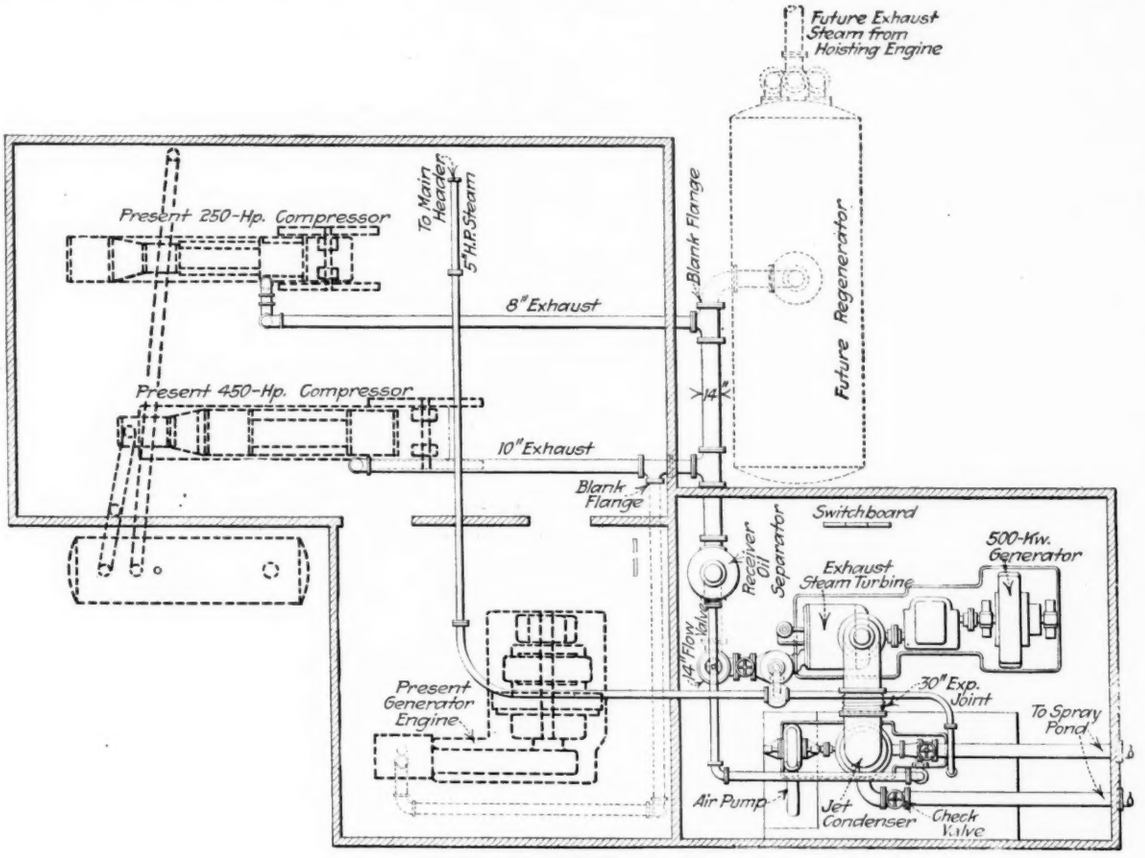
As shown in the layout drawing, steam from the two compressors passes through a vertical receiver oil separator and thence through a 14-in. flow valve to the low-pressure turbine. A 5-in. live-steam connection is made from the new steam header to the turbine to carry the load when sufficient exhaust steam is not available. At the top of the receiver oil separator a 14-in. relief valve allows any excess steam to pass to the atmosphere. The condenser is also provided with a 12-in. automatic relief valve.

New Equipment Reduces Labor Cost

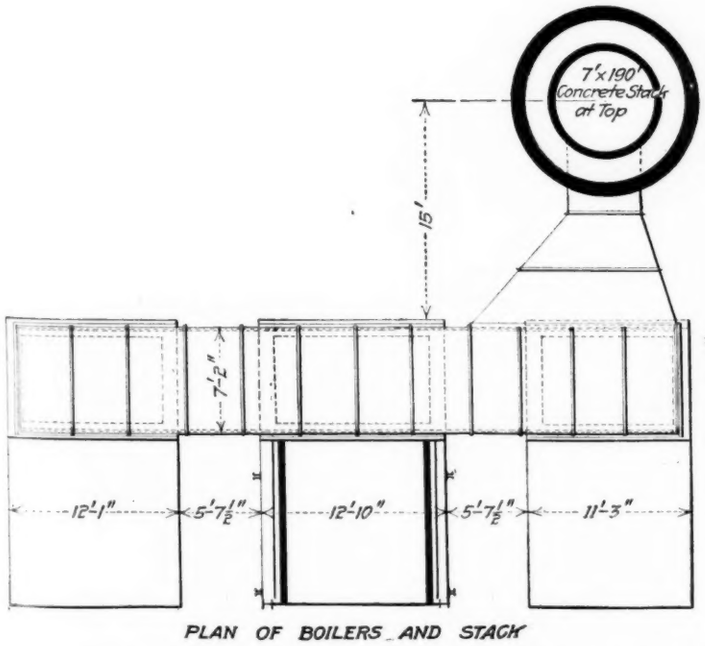
By the installation of this new equipment the number of firemen was reduced from nine to four and the ash wheelers to one, the latter reduction being due to the installation of a steam-jet ash conveyor. As the operating shifts at the mine are eight-hour periods and the day shift is the only period of heavy load, the

ashes during the other two shifts are easily taken care of by the fireman operating the boilers. As a matter of fact there is sufficient ash storage under the boilers to allow accumulation for 16 hours.

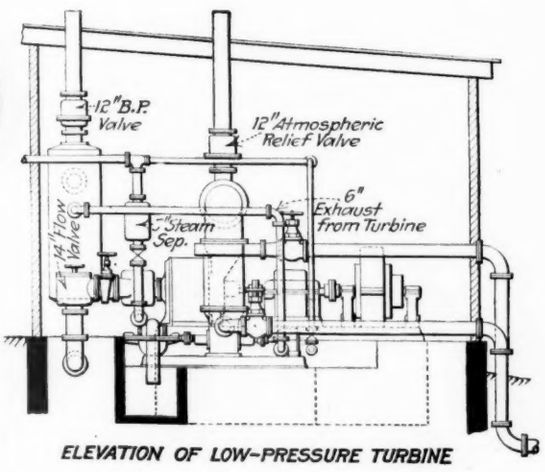
The plant has been in operation for 21 months, and the owners claim that the improvements have already paid for themselves. Besides, by releasing the air compressors from supplying the mine pumps, the capacity of the mine has been increased from 2000 to 3000 tons of coal per day. This in itself is a great advantage at this time, when coal is in such urgent demand and the price is higher than it has been for years.



PLAN OF ENGINE ROOM



PLAN OF BOILERS AND STACK



ELEVATION OF LOW-PRESSURE TURBINE

As a result of the improvements the coal consumption was reduced from 90 tons of No. 4 washed coal per day to 45 tons of No. 5 washed coal. At present prices this means a saving of approximately $135 per day.

The Electrical Study Course—The Dynamo

Consideration is given to the generation of voltage in a two-pole machine having a ring armature, and the distribution of the current in the armature winding.

SO FAR we have only considered dynamos that have one coil of a single turn of wire on the armature. In the commercial type of machines the armature contains a number of coils. On the small-sized machines the armature is usually wound with a small number of coils having a considerable number of turns of small

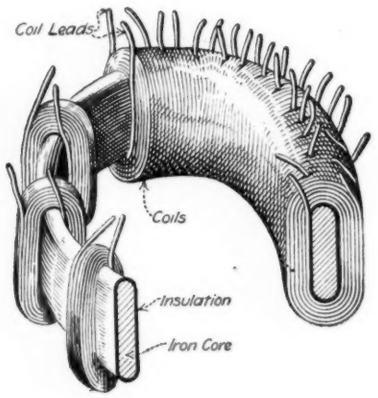


FIG. 1. RING ARMATURE IN SECTION

wire, whereas in the large-sized machines the armature is wound with a large number of coils of large wire having a small number of turns, usually one turn made from a copper bar. We have also learned that there are two types of armatures; namely, ring and drum.

The ring armature consists of an iron ring with the coils wound around it as in Fig. 1, where the coils on a drum armature are placed on the surface of the core, or in slots in the surface of the core, as in Fig. 2. Fig. 2 shows three coils in place and how the coils fall over one another to form a complete winding, as in Fig. 3. In the drum-type armature the spread of the coils—that is, the number of slots spanned by a coil—is determined by the number of poles. For example, in Fig. 2 the coils span approximately one-quarter of the core, which would indicate that this armature is intended to operate in a four-pole field frame. In the ring armature the distribution of the winding on the core is the same, irrespective of the number of poles, where in the drum armature the coil spans approximately the distance between the centers of adjacent poles.

Although there is no difference in the two types of armatures so far as voltage generation is concerned, when it comes to a consideration of the various elements that take place in the windings, the ring type lends itself much more readily to a theoretical discussion, therefore will be used in our consideration of this subject.

In Fig. 4 is shown, diagrammatically, the complete layout of a dynamo-electric machine having an armature of the ring type. Coils of wire, designated field coils, are placed on the polepieces. The winding on the armature is shown, for simplicity's sake, to be continuous for the entire circumference of the core and closed on itself, with a tap taken out at each turn of the winding to a bar or segment in the commutator. This winding could have been shown grouped into coils, as in Fig. 5, with the leads of each coil coming out to two commutator bars, as shown, which is generally the way the job is done in practice, but for our purposes Fig. 4 is better suited. The winding in Fig. 5 has twice as many turns as that in Fig. 4, consequently, will generate twice the voltage under a given condition of speed and field strength.

In Fig. 4, if a current is caused to flow through the field coils in the direction shown, it will cause the top polepiece to become south and the bottom one north polarity, and the magnetic flux will flow in the direction indicated. Then, if the armature is revolved in the direction of the curved arrow, the conductors under the S pole will be cutting the lines of force in a left-hand direction, while those under the N pole will be cutting the flux in a right-hand direction. The lines of force are moving upward, from the N to the S pole, in each case, therefore, by applying the rule for determining the direction of electromotive force, it will be found that in the conductors under the S pole the voltage is down through the plane of the paper, while in the conductors under the N pole it is toward the reader, as indicated by the arrowhead. It will be seen that all the voltages generated in the various conductors under the S pole are in series assisting one another, likewise under the N pole. Therefore, the sum of the voltages generated

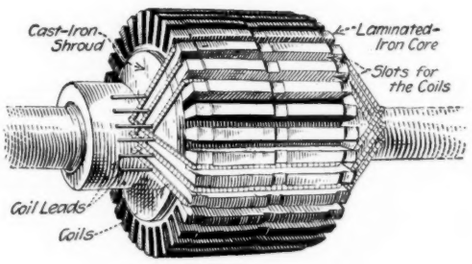


FIG. 2

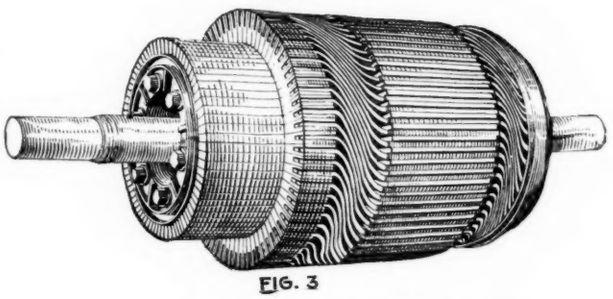


FIG. 3

FIGS. 2 AND 3. DRUM-TYPE ARMATURE

in the conductors under one pole is the voltage that will appear at the brushes when the latter is in the position shown. It will also be seen that the voltage in the windings under the N pole opposes that generated in the conductors under the S pole. Since the voltages

in the two halves of the windings are equal, or at least should be, no current flows in the winding as long as the circuit is open between the two brushes.

The question of electromotive-force generation was discussed to considerable extent in some of the earlier lessons, and it was pointed out that the device which supplies the current to the circuit does not generate the current, but produces a voltage that causes the current to flow in a conductor when it is connected no current can flow around in the winding until the brushes are connected to an external circuit *C*, as in Fig. 6. In the figure the external circuit is shown on the center of the commutator; however, this is for simplicity's sake only, as this circuit might be a motor or a group of lamps, or any device that requires an electric current for its operation, and might be located at a considerable distance from the machine.

The generator in an electric circuit is the same as a pump is in a circulating system. The pump does not generate the fluid that it causes to flow in the system, but creates a pressure that causes the fluid to flow in the pipe line. Likewise an electric generator only produces the pressure that causes the electric current to flow in the circuit.

The two halves of the armature windings in Figs. 4, 5 and 6 are similar to two voltaic cells in parallel. In Fig. 6 it will be seen that the electric pressure generated in the conductors under the N pole causes a current to flow out from the positive brush through the external circuit *C* and into the negative brush, as indicated by the arrowhead; likewise, for the conductors under the S pole. Since the two halves of the windings are in parallel, the voltage appearing at the brushes will be that developed in one half of the winding, just as when two voltaic cells are connected in parallel—the voltage of the group is equal to that of a single cell. Also, each half of the winding will supply one-half of the current in the external circuit; that is, when the armature is supplying 30 amperes to the external circuit *C*, 15 amperes will be flowing in the conductors under the N pole and 15 amperes in the conductors under the S pole. This is again the same

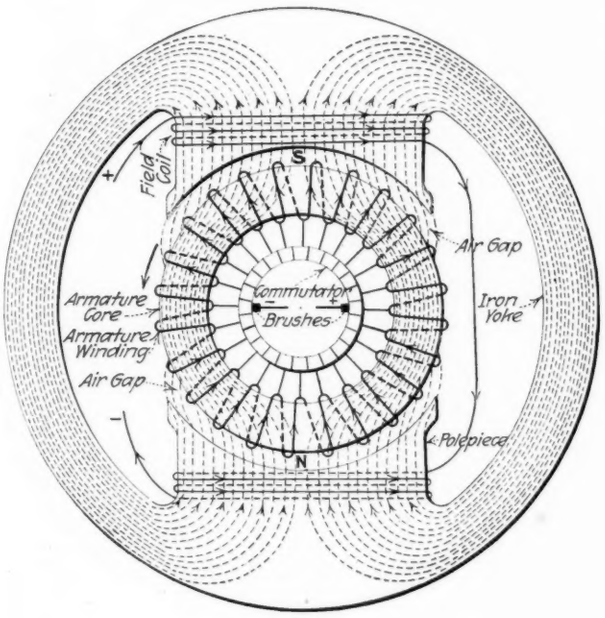


FIG. 4

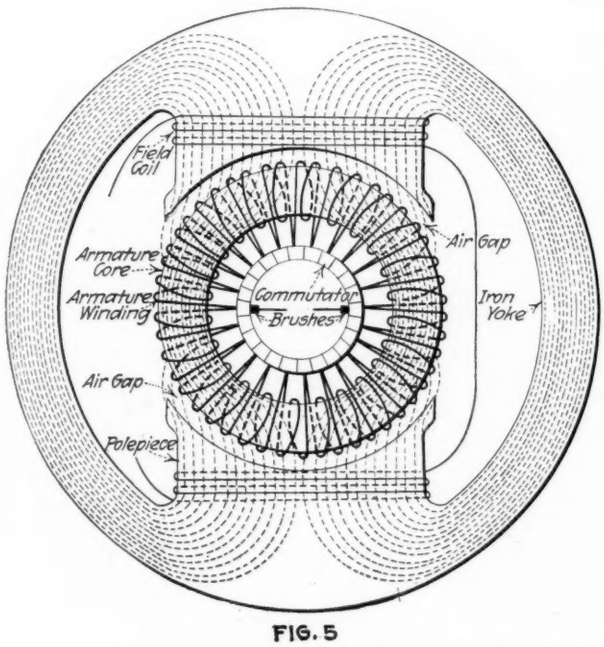


FIG. 5

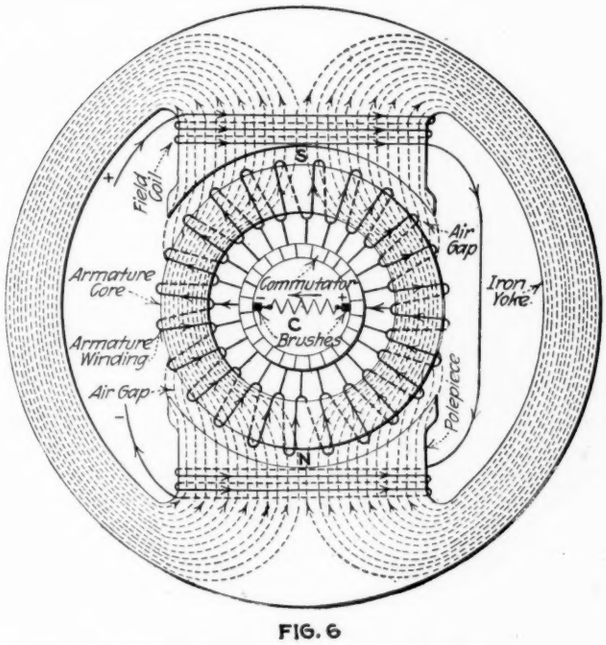


FIG. 6

FIGS. 4 TO 6. DIAGRAMMATIC REPRESENTATIONS OF A RING-ARMATURE TYPE GENERATOR

between the positive and negative terminals of the source of voltage. This is just the condition we have in Fig. 4. The conductor on each half of the armature cuts the line of force and generates a voltage; however, the arrangement of the winding is such that the voltage in one half opposes that in the other half, and as when two voltaic cells are connected in parallel and supplying current to a circuit—one-half of the current is supplied by each cell.

All the foregoing discussion has been in reference to two-pole machines. The general principle applies to multipole machines, although the division of the

current may be somewhat different in the winding, as will be seen in our discussion on this subject in future lessons.

Fig. 7 is a layout of problem 1 given in the last lesson. This circuit may look complicated, nevertheless it is the equivalent of three resistances in parallel. There are three circuits from A to B: One directly through $r_5 = 6$ ohms; another, which we will call R' through r_1 and r_2 in series $= 2.5 + 7.5 = 10$ ohms; and the third, which we will designate as R'' through

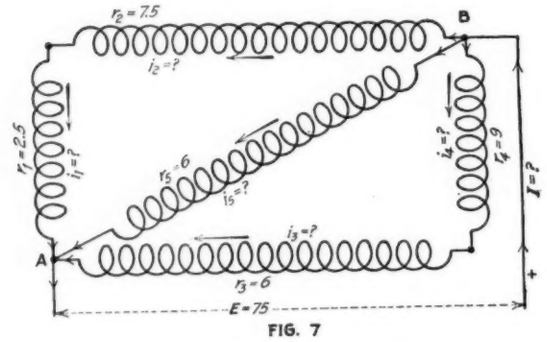


FIG. 7

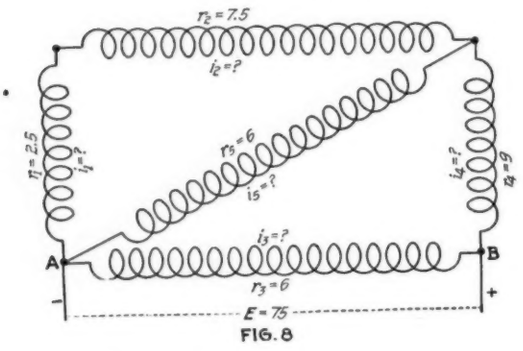


FIG. 8

FIGS. 7 AND 8. COMPLEX CIRCUITS

r_3 and r_4 in series $= 6 + 9 = 15$ ohms; that is, three resistances R', r_5 and R'', in parallel, of 10, 6 and 15 ohms respectively. That there are three circuits parallel is indicated by the flow of the current shown by the arrows.

The joint resistance of the circuit is

$$R = \frac{1}{\frac{1}{R'} + \frac{1}{r_5} + \frac{1}{R''}} = \frac{1}{\frac{1}{10} + \frac{1}{6} + \frac{1}{15}} = \frac{1}{\frac{10}{30}} = \frac{30}{10} = 3 \text{ ohms}$$

The total current flowing in the circuit equals total volts divided by the joint resistance of the circuit, or

$$I = \frac{E}{R} = \frac{75}{3} = 25 \text{ amperes.}$$

$$i_1 = i_2 = \frac{E}{r_1 + r_2} = \frac{75}{2.5 + 7.5} = 7.5 \text{ amperes;}$$

$$i_5 = \frac{E}{r_5} = \frac{75}{6} = 12.5 \text{ amperes;}$$

$$i_3 = i_4 = \frac{E}{r_3 + r_4} = \frac{75}{6 + 9} = 5 \text{ amperes;}$$

and the total current equals the sum of the three, or $7.5 + 12.5 + 5 = 25$ amperes, which checks the foregoing calculation.

In problem 2 of the last lesson the circuit took 15 hp. when 115 volts was applied to it. To find the current, first find the watts, which equal $W = \text{hp.} \times 746 = 15 \times 746 = 11{,}190$ watts. Then $I = \frac{W}{E} = \frac{11{,}190}{115} = 97.3$ amperes. This might have been expressed as $I = \frac{\text{hp.} \times 746}{E} = \frac{15 \times 746}{115} = 97.3$ amperes. The total resistance $R = \frac{E}{I} = \frac{115}{97.3} = 1.18$ ohms. R also equals $\frac{E^2}{W} = \frac{115 \times 115}{11{,}190} = 1.18$ ohms.

In Fig. 8, in addition to determining the values indicated by the interrogation marks, find the joint resistance of the circuit.

Engine Troubles Due to Carelessness

BY CHARLES W. OAKLEY

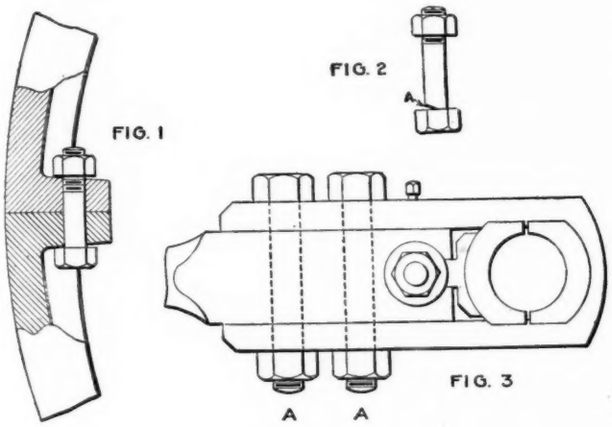
There is a weakness on the part of many engineers to consider the man sent out by the builder to erect an engine or turbine as almost infallible. While this man is usually a thorough mechanic, conscientious and painstaking in his work, occasionally one is met whose idea of his own importance either overcomes his judgment or else takes the place of the knowledge and experience which he is supposed to have. This is due in a large measure to the attitude of many superintendents and managers, who, because the erecting man is invested with considerable responsibility, defer to him and seek his opinion not only on questions pertaining to the machinery being installed, but on matters concerning the operation of the plant, with which the chief engineer is much better acquainted and probably has vastly more experience.

A case of carelessness on the part of an erecting man, which might have resulted in a disastrous accident, occurred in putting together a flywheel weighing about sixteen tons, made in halves and bolted through flanges at the rim and the hub. When the wheel was put on, the heads and nuts of the bolts had a bearing on the flanges at one side only, as shown in Fig. 1. The engineer protested to the erecting man, who explained that it was unnecessary to face off the flanges to secure a full bearing, as it was the custom of his firm to make the bolts and flanges several times as strong as required, and therefore no harm could ever occur. However, he suggested that copper washers be placed under the heads and nuts, explaining that the copper would allow the heads and nuts to bed themselves until a full bearing was obtained. This was done, the bolts being pulled down considerably tighter than would have been necessary had they had a full bearing on the flanges. The engineer was then instructed to tighten the bolts at intervals, after running a few days, and eventually they would have a uniform bearing.

The engineer obeyed his instructions; but one morning shortly after the engine had been put in service, when he started to tighten up one of the nuts, he was surprised to find that it turned quite easily. The bolt, on being removed, was found to be cracked about halfway through under the head, as at A, Fig. 2. Examination of the other bolts disclosed incipient fractures in three of them. It is hardly necessary to describe what would have happened to that wheel before many hours.

No time was lost in getting the engine builders on the job and having them face off the flanges until the new bolts which were secured had a proper bearing on the flanges.

One of the errors made by engineers, and sometimes by erecting men, is the improper fitting of bolts. Some engineers are of the opinion that so long as a bolt is amply large for the work it has to do, it is of little



FIGS. 1 TO 3. EXAMPLES OF CARELESS FITTING
Figs. 1 and 2—Effect of poor bearing of flange bolts. Fig. 3—Design of connecting-rod end.

consequence whether it fits closely in the hole or not. They argue that the job is all right because the nuts are drawn up tight. Later on, evidence of shifting of the parts that are bolted together may be detected through the appearance of rusty oil at the joint or under the bolt head. Whenever an indication of this kind appears, the nut should not be tightened further, but the bolt should at once be removed and an examination made to ascertain whether there is any fracture of the bolt or the casting. The hole should be tested for alignment, to see whether a bolt the full size of the hole will go all the way through. If not, the parts should be held firmly together in their correct relative positions and the hole should be carefully reamed out. Then a bolt of proper size should be obtained and turned to fit the reamed hole snugly.

In making a flywheel or a large belt wheel in two or more sections, it is customary to plane off the joints and flanges of the wheel, and then bolt the sections together before turning and boring the wheel. It is rare, however, that a wheel is bolted together as firmly for this purpose as it is when placed in position for service; consequently, when the wheel is put in place on the shaft, some slight distortion frequently occurs at the bolt holes, especially when the arms are bolted between hub flanges. Great care should be taken to have the bolts well fitted to holes reamed out carefully, and no springing, prying or drifting should be allowed in making up these bolted joints. Not only must the head and nut of each bolt bear fully and squarely on the surfaces, thus insuring a straight pull on the bolt, but the shank of the bolt should present its full shearing area at all points in the joint.

Other parts of the engine besides the flywheel are susceptible to danger and trouble from ill-fitting bolts. To illustrate, the crosshead end of a large connecting-rod developed a very annoying pound shortly after it had been fitted with a new set of brasses. Upon taking down the connecting-rod at the crosshead end, which was of the design shown in Fig. 3, it was discovered that the bolts *A* were slightly loose in their holes and had necks cut into them by the strap, thus allowing some movement of the strap.

When this condition of affairs was pointed out to the engineer, he confessed that as the brasses had been found slightly large between the strap and the wedge, he had filed the bolts down so that they would pass through the holes in the rod end, thus avoiding the trouble of taking out the brasses again to plane them off. It was necessary to secure new bolts and ream out the holes in the strap and rod to fit. The pound then disappeared.

In erecting a large engine it is usual to locate the pillow block or pedestal on the sole plate by means of dowel pins, as shown at *A*, Fig. 4. The sole plate *B* is first lined up and leveled properly, and when the foundation has hardened sufficiently the pedestal is set in place over the dowel pins and held firmly by means of the anchor bolts *C*.

It is inadvisable to have the anchor bolts fit closely in the holes in the sole plate and pedestal, as shifting of the bolts while the foundation is being built would prevent the placing of the pedestal over the bolts. To allow for slight lateral movement, therefore, they are usually set in boxes *D*, with pockets *E* in the foundation at their lower ends, so that a wrench may be inserted

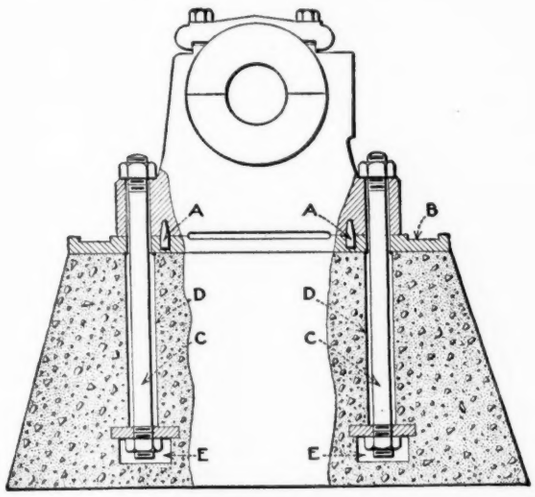


FIG. 4. DOWEL PINS TO PREVENT PILLOW BLOCK FROM SHIFTING

to remove the lower nuts and allow the bolts to be drawn up and replaced in case injury or breakage requires their renewal.

Allowing the anchor bolts to become loose permits the pedestal to work back and forth, slightly at first, but gradually increasing in movement until the dowel pins are sheared or broken off, leaving the position of the pedestal dependent entirely on the tension of the anchor bolts. A serious accident resulted from this cause some years ago. The movement of the engine frame caused such excessive vibration of the governor standard that it broke or sheared off the studs securing it to the engine frame. The breaking loose of the governing mechanism resulted in a runaway that wrecked the entire plant.

What of the Labor Situation?

WHAT of the labor situation? Let us face the facts. Labor is stronger today than ever before. It has tremendous power. It can for short periods stop industry. Within reason, it can force almost anything it will. If it goes to extremes, the rural communities and large groups in the cities will rise to check and thwart its demands. Nevertheless, if misguided, it can work serious hardship. What, then, is its purpose? How will it use its power? Is it bent on a rule-or-ruin policy? Or, seeing the good in the existing order and conscious of the sure control that lies in the mass of the people, is it desirous of compromise?

Emphatically the latter is true—speaking as to the majority of the acknowledged labor leaders. Their desires cannot be realized unless capital comes half way. If capital resists, if it is represented—or rather misrepresented—by those who take an autocratic stand, it will force millions into the radical wing of the labor party, it will add fuel to fires already burning.

These are not the days for sugar-coating the pill. The coward will cringe from facing the facts. He will roundly condemn those whose object is to save him—and with him the essential elements in the present social order. Charles M. Schwab said a few days ago that the worker was to dominate the world. A more temperate statement is that of former Supreme Court Justice Hughes, a student of industrial relations, accustomed to consider and weigh. Before the New York Bar Association last month he said:

"Individual privilege [in the future] will have to show cause before a public to which old traditions are no longer controlling—a public trained in sacrifice—which will enforce its own estimate of the common right." And again he said: "The present exercise of authority over the lives of men will hereafter find its counterpart in a more liberal exercise of power over the conduct, opportunities and possessions of men."

Mr. Schwab and Justice Hughes had the courage to recognize the changing order. Narrow minds, however, will rail and rant, urge that capital prepare to fight for its position, and declare that no man shall dictate how they shall run their plants. Such minds are not changed by dissertations on the reasonableness of the new order, which decrees that the public good shall take precedence over private gain, that the public cares for the individual and demands that he have a voice in determining the conditions under which he works.

It is a matter of indifference, in any event, what the individual thinks as to the soundness of the coming order. We are in a new era, in fact. Witness the fires raging socially in Russia and now kindling in Austria and even in Germany. Note the power which labor has in England.

We are in and of the world. The power drifting to the workers here is part of the world tide. Whither will it lead us?

Even as there are standpat autocrats as well as men of enlightenment among employers, so there are radicals and conservatives among labor. The autocrats on the one hand and the radicals on the other are the extremists. If they are left to lead us out of the difficulties, we shall have an arming for conflict and a great catastrophe. It is for those who see the light to compose the differences—the moderates among the employers, the conservatives among the workers.

These wings of the opposing parties can reach a working agreement. They must come together in order that the extremists may be disarmed—aye, that they, and the country with them, shall be saved from their own madness. The final result will work for the greater good of all. "Harsh changes are necessary," said Mr. Schwab, "but they will be more than repaid not only materially, but in happiness and contentment."

Practically, what is coming out of the present economic crisis? Detailed predictions are dangerous. This much is certain: (1) Labor will demand and get a larger share of the profits of industry, and (2) it will demand a voice in each industry in determining the conditions under which it shall work.

Is that a cure-all? Will all labor difficulties be then composed?

Not so. There is not an absolute unity of interest; there cannot be a permanent peace. All we can hope for is compromise under conditions that obtain today. When conditions change, there will be a new compromise, succeeded by another and another and still another. But the present compromise will be the greatest for many a day, for it will definitely establish labor's voice in the control of industry.

And what of the industries that pay a bare 4 or 5 per cent. on a fair or low valuation of investment? Bankruptcy or a reduction of overhead through increased production. These are the only alternatives.

And what of efficiency, now at a low mark in industrial plants? Education is the answer—education, through participation in management, regarding the factors which affect profits; education which will engender a sense of responsibility for the success of the industry, a realization that there can be no labor prosperity without industrial prosperity—a realization that will be turned into effective action by confidence that labor will get "its share" of the profits it helps to create. A long process, yes, but a necessary one.

And efficiency is a shoe that both parties can wear. Management inefficiency more than matches, count for count, labor inefficiency.

Radical talk this? Yes, if you will have it so, but read again the words of Charles Schwab and of Justice Hughes.

Shall we fear to face the facts? Shall we, by ignoring conditions that the merest numskull can appreciate, drift into anarchy? *Laissez faire* and "last-ditch resistance" both lead to that end.

Soon there will meet in Washington a Labor Policy Board. It will hold the balances for our industrial peace. There must be give and take—compromise. Both sides must surrender much that they value highly. Far-seeing employers are ready to make sacrifices. So, too, are the forward-looking labor leaders. The interests of the country demand that both sides look carefully to it that they be not misrepresented. And above all let both be prepared for large concessions. In that direction lie peace and the country's good.—*E. J. Mehren in "Engineering News-Record."*

Editorials

What Is Labor Unrest?

THE human mind is the most complex piece of mechanism in the world. It is the master mechanism. How it works nobody knows. What it will do individually and collectively under any given conditions nobody knows—not even its owner.

The man who digs your ditches has depths you cannot plumb. You see him come and go every day and his coming and going become a part of your daily habit of thought, like the coming of your morning newspaper. Some day he doesn't blend with the scenery as you are accustomed to viewing it. Unknown to you there has been some crisis in his life; his mental depths are in turmoil; age-old questions come to the surface. Placidity becomes turbulence and you are annoyed—unless you have become similarly turbulent yourself, in which event you are not annoyed. You understand.

Your ditch digger has thousands of years of his ancestors' life and thoughts and yearnings slumbering in his soul and speaking when he is roused. He has not always been a ditch digger. Some centuries past in Asia Minor, in Greece, in Italy, along the whole line of civilization's push upward, he has been oppressor and oppressed, just as you have been—mostly oppressed, for the oppressed have always been in the majority.

One life begins and ends; but the blood-flow is continuous from generation to generation. The thousands of years behind us speak in us and to us and through us every day. The greatest thinkers, ancient and modern, affirm this.

There has been more stirring of the human depths since August, 1914, than there had been in the whole period since our Civil War. All of our accustomed grooves have been upset. In our social bearings we lack a sureness of direction. The guide posts have become weather vanes. Our placid gray matter has been set seething. The former smooth surface of our minds which reflected the current weather, the passing clouds and the orderly seasons, is turbulent; the sediment of the centuries is bubbling to the surface from the depths.

We get into channels. Channels are comfortable. They fix direction. Where you are going doesn't worry you. It suffices that you are comfortably on your way. Then something happens and destroys the channel. You and your ditch digger face each other with the eternal question of your mutual relationship in your eyes. The thousands of years back of each of you is compacted in the look. *And you couldn't phrase the question in words if you tried.* You don't try, either of you. Instinctively you know it, but to save your souls neither of you could say it.

If you tried to say it, you would both use the words you used in the channel—wages, open shop, cost of living. Especially the ditch digger would. He couldn't phrase the concentrated protest of ten thousand years in a moment of crisis any more than he could think it logically in a year in the channel. It is too big, too overwhelming, too much a rising of his whole being. So when you ask him what he is turbulent about, don't quibble about the lack of a clear-cut answer. It can't be made; you couldn't make it yourself. But if you want his answer, get it in his reactions. Hear him give approval to war against the Kaiser; note the set of his features when the war profiteer is mentioned; watch him as he listens by the hour to the man you would call an agitator; catch his constant sanction to the opportunities open alike to everybody and his equally constant suspicion of opportunities not possible for *his* children. The public schools are never afraid to go direct to the people for money; the universities are.

Business based on the idea of maximum cash returns to the owner, at any cost to competitors, to labor, to the social order, to the Government, was bound to be a boomerang.

The labor unrest is the instinctive protest of ten thousand years against all this.

New Jersey Plants Closed from Lack of Coal

NOTWITHSTANDING the fact that suspension of heatless Mondays was announced on February Thirteenth, by Fuel Administrator Garfield, with the reservation, however, that the suspension order might be revoked before the ten-week period expired if a return of cold weather should bring another breakdown in railroad transportation, it strikes one as being somewhat premature when viewed from the state of local conditions and those prevailing in New England.

Although heatless Mondays have been abolished, a large number of industrial plants in northern New Jersey were forced to stop or curtail work the day prior to the Fuel Administration order, because of the cutting off of electric power by the Public Service Electric Co. of Newark and the Public Service Corporation of Jersey City, due to lack of coal.

Many of the plants affected have important war contracts, and about 50,000 employees were made idle. It was announced by officials of both companies that the shutdown would probably continue until February twentieth.

It is believed that the manufacturers in this district have cause for complaint because of the alleged failure of the Fuel Administrator to keep his promise, made about the middle of January last, to the effect that the Public Service Corporation would be supplied with enough coal to keep it going. It is understood that a delegation from Jersey City, Hoboken, the Bayonne Chamber of Commerce and the Newark Board of Trade visited the Washington fuel authorities and were told by them that arrangements would be made with War and Navy Departments whereby the coal would be shipped ostensibly to the army, but would be delivered in Jersey City to the corporation. The corporation

officials declare that this plan was never carried out properly, that although for a time they got coal from what is known as the tidewater pool, a few days ago the pool refused to deliver coal.

It seems incredible that such a situation should have been allowed to come to a head as to compel the shutting down of a chain of large power plants, especially when so many companies are using their current for manufacturing war materials.

Improve Plant Efficiency

SHORTAGE of labor limits the output of the mines, and scarcity of cars hinders coal distribution. With the demand far in excess of production, there is one way that will help to relieve the shortage. Save coal at home and, more important still, save it in the power plant. Make nine pounds of coal do the work ten pounds did before, and then see if the economy cannot be bettered. There is many a plant in which this ten per cent. saving might readily be increased to thirty, and in some cases it would be possible to cut coal consumption in two without reducing the output.

It is not a question of installing new and more efficient machinery. Manufacturing and transportation facilities are not available, and if they were, the time element is too pressing. Relief is needed at once. The solution is to improve the plant as it stands. The worse the condition the greater the saving possible. The opportunity exists and all that is needed is intelligent attention by every power-plant owner and engineer in the country.

A real engineer well knows what is needed. He will look to air leaks in the boiler setting and stop steam and water leaks in the piping. He will adopt proper firing methods for the coal he is burning, see that the draft is right and keep the heating surface free from soot and scale. All equipment in the engine and pump rooms will be kept in good order. The valves will be properly set, and the bearings will be kept cool by sufficient lubrication. In a word, the plant will be maintained in the "pink" of condition.

All this necessitates a competent engineer, a good fireman, a system of records showing accurately what is being done and the necessary instruments with which to obtain the operating data. And here is the owner's opportunity. He must choose his man wisely and then provide him with every facility possible that will help to produce the most efficient results.

In those plants not containing mechanical stokers the fireman is the biggest single factor to be considered. Good men of this trade are scarce, and it is a question of educating the material at hand. Higher-priced fuel has helped to eradicate the idea that the fireman is a common laborer subject to the treatment of a roustabout. As fuel prices go up the margin between good and indifferent work means more and more of the firm's money. It will be found cheaper to educate the fireman than to pay for coal, and the laborer will be raised to the plane of a skilled workman. In this process valuable information may be obtained from the Bureau of Mines, various schools and engineering associations will contribute to the cause, and *Power* stands ready to supply all information at its command.

Prompt action by every power plant in the country would easily increase the average economy ten per cent. It would mean millions of tons of coal for war purposes, resulting in more rapid mobilization of men and supplies at the front by our own country and our allies. It would contribute toward shortening the war and at the same time mean a saving to the power-plant owner. This is no sacrifice. Like buying a Liberty Bond with interest and principal returnable, it is the duty of every patriotic engineer and power-plant owner to contribute to the cause.

Names! Names! Names!

THE following appeared in the New York *Sun* o February 15. Why is it that "The names have not been made public"?

COAL MEN INDICTED

Tennessee Operators and Dealers Held for Food Law Violations

Knoxville, Tenn., Feb. 14.—The Federal Grand Jury here today returned twenty-three indictments against forty-seven defendants, including coal operators, coal dealers and coal brokers of the east Tennessee field, charging violation of the food-control bill. The names have not been made public.

The indictments include 163 counts. The cases will be called for trial here at the May term. The indictments resulted from investigations made during the last two months by the Department of Justice, which developed charges of violations of Government fixed prices and Fuel Administration order.

Give us their names.

Coal Piracy Under Ban

Sale of rock and slate masquerading as coal is going to be discouraged, C. E. Robertson, deputy state fuel administrator, said today.

"Within the past few days," he added, "this office has had rejected two cargoes of which an analysis showed 69 per cent. of rock and slate and only 31 per cent. of coal. The railroad companies carrying this coal notified the producers in Pennsylvania that no more cars would be furnished to them. If this stuff had been accepted by the consignee, it would have cost him $26 per ton for the coal in it."—*N. Y. Globe, Feb. 14.*

And even at that he could not have burned it.

There is nothing to be gained by holding meetings, writing papers and editorials to argue that the Monday closing orders of the Fuel Administration have saved little, if any, coal. Their object was not to save coal, but to relieve the bunged-up conditions of the railways. It is a pity that some of these intellectual giants cannot see how absurd some of their advice and comments appear in the light by which those who have great responsibilities are doing big things.

The *Engineering and Mining Journal* will say the following, editorially:

The days of suspended industry in February may or may not be costly, but it is certain that they were not so expensive as the New York dailies represented last Sunday, on the authority of the *Black Diamond*. They put the loss for eight days at $4,344,000,000, which would be $543,000,000 per day, or at the rate of $162,900,000,000 per annum, reckoning 300 days. Inasmuch as the gross volume of business in the United States in 1917 is estimated at about $50,000,000,000, there is manifestly something wrong in estimating the loss of about eight per cent. of that sum in eight days.

Correspondence

Why Hot-Water Pipes Pit

On page 824 in the issue of Dec. 18, 1917, a description was given of the pitting of steel pipes used for steam and hot-water lines. Two instances were given, and the question was asked, "What is the reason?"

There is a possibility, as mentioned in the article, that there was originally in the steam pipe a pin-hole through which the steam escaped, gradually wearing the hole larger and larger and that it was, therefore, not a case of corrosion but of erosion. The other case, however, is typical of corrosion in hot-water lines, which is one of the everyday troubles of power-plant engineers and is satisfactorily explained by the electrolytic theory of corrosion. According to this theory corrosion is caused by electric currents emanating either from outside sources or in the material itself. In the latter case the elements necessary for corrosion to occur are as follows: (1) Impurities or other conditions in the metal, causing different electrical potential in adjoining areas thereof; (2) an electrolyte—commonly water; (3) a depolarizer—air or oxygen. With these conditions prevailing, a current is set up which dissolves the metal at the electropositive pole, resulting in oxidation and precipitating of rust at this point, where the pit will subsequently be observed.

It will be seen that if oxygen can be excluded from a water line, corrosion will not take place; likewise that corrosion will to some extent be accelerated or retarded according to the amount of free oxygen contained in the water. From the oxygen content of the water viewpoint one may reason out the relative corrosive effects of water, steam and moisture in various forms, and it will be seen from the following that the corrosion in hot-water lines is, in the light of the electrolytic theory, calculated to be very severe, agreeing with actual experience. Hot water, under certain conditions, as will be explained, is very destructive to the life of ferrous metals.

The experiments of Heyn and Bauer in 1910 indicate that the corrosion of iron in hot water increases with the temperature, reaching its maximum at about 140 deg. F., where the effect is about four times as great as at normal temperatures. Above 140 deg. the corrosion decreases with increase of temperature, and above 176 deg. the falling off is rapid and the corrosion should be very slight at the boiling point (212 deg.) because of the expulsion of oxygen from the water.

When iron is immersed in hot water, there are opposing forces to be considered:

1. Corrosion should be increased because: (a) The conductivity of the water as an electrolyte becomes progressively greater with increase of temperature to the boiling point. At this point it may be several times as great as at normal temperatures, and thus there may be several times the current density with its equivalent solution of iron for the same potential difference set up between the iron and any electronegative substance. (b) With rise of temperature there should be increased speed of reaction between the iron and oxygen in the formation of the rust.

2. Corrosion should be decreased because: The solubility of oxygen in water decreases with rise of temperature, becoming nil at the boiling point.

The amount of corrosion at any temperature will depend on the balance of these forces. As indicated previously, the observed effect is an increase to a maximum with subsequent decrease from this temperature to the boiling point of water.

In hot-water supply and heating systems the corrosive action will depend largely upon conditions of design, installation and operation. At best there is a tendency for marked acceleration of corrosion because of the increased electrical conductivity of the water up to a certain temperature; also because of the evaporation of the water—as in all closed circulating systems—which will result in increased concentration of salts in solution as compared with the natural supply. If an open system is used, where the water is brought to the boiling point and the greater part of the liberated oxygen is allowed to escape before entering the pipe system, corrosion may be very much reduced in spite of other influences in its favor. But with the customary closed system conditions could hardly be more favorable for maximum effect, owing to the accelerating influence of high temperature and probable concentration of salts in solution, coupled with a maximum content of oxygen, since the latter cannot escape from the closed system and is forcibly kept in solution by the relatively high working pressure.

The electrolytic theory of corrosion, or the difference of electrical potential in adjoining areas of a metal, may, as mentioned, be caused by impurities contained in the metal. On this theory it might be thought that high purity of metal would prevent, or at least greatly reduce corrosion. But the high-purity commercial irons apparently do rust just as quickly as ordinary steel, and metallurgists were therefore forced to look for other causes besides high purity. They then discovered that different polarity, causing electrolytic action, may also be due to: (1) Distortion or unevenly strained parts in the metal (caused in pipe by applying a wrench in tightening a joint, bending the pipe or the like); (2) lodgment of foreign matter or mill scale on the metal surface.

In addition it has been found that rust is of a different electrical potential from that of iron or steel and, when once formed on the surface, becomes the cause of further rusting or pitting. In other words, rust breeds rust, becoming such an important factor in the progress of corrosion that original purity of metal and the other causes mentioned assume comparatively little importance. While the electrolytic theory of corrosion, when properly interpreted, is a valuable guide

to the understanding of the subject, it cannot be used for the purpose of reasoning out how any metal of a given composition will behave in actual service. Experience with the metal under service conditions is the best guide. The metal may, for instance, be very impure, like cast iron, and yet be fairly rust-resistant. This is assumed to be due to the barrier action afforded by these very impurities, principally the graphitic carbon, which in itself is highly rust-resistant and protects the underlying iron from corrosion by preventing penetration of the water or oxygen. In respect to the nature of other forms of iron considerable confusion exists, and the following may therefore be in order:

By commercially "pure iron" we understand certain products of the openhearth processes which should more properly be called pure steel, for they lack both the graphite contained in cast iron and the slag contained in genuine wrought iron. We know that wrought iron is a very durable product in spite of the large proportion of slag which is incorporated in the pure iron, but we should not be misled into construing this as a contradiction of the electrolytic theory, for it is apparent that the slag, like the graphite in cast iron, being in itself a practically noncorrodible substance, must on account of its fine distribution, protect the underlying iron from corrosion.

N. BOWLAND,
Pittsburgh, Penn. A. M. Byers Co.

Water for Air Pump

I would like to add the following to what the readers of *Power* have contributed to the subject of the source of water supply for the air pump of Mr. Forseille, as told by him in *Power*, Nov. 20.

The first change to make is to lower the strainers and then connect up the new proposed line to the intake of the strainers, with a gate valve in the line so as to cut out the new line when the slush ice disappears. This will melt the slush ice by mixing the water, and a temperature from 60 to 70 deg. F. can be held in the air pump intake water. The temperature of the intake should be below 70 deg. The pump gets more or less vapor or steam from the condenser, but as long as the temperature is kept below 70 deg. F. the efficiency of the pump will not be appreciably reduced. Cold water is two-thirds of the battle in condenser operation.

North Kansas City, Mo. P. B. WILLIAMSON.

Providing Stand-by Service

In an industrial power plant where only one generator was provided, on which the maximum load never exceeded 75 per cent. of the unit's rated capacity, it was getting to be quite a problem to find sufficient time to make the necessary repairs and adjustments. Somebody always requires light and power, and although the load was small on nights and Sundays, it nevertheless caused considerable inconvenience if the engine was shut down for any length of time. The management did not feel inclined to buy another engine as long as this one was not loaded up to capacity. The figures offered by a central station for stand-by service were such that they could not be even considered. The central staton offered to take the entire load at a reasonable rate, but as all the exhaust steam was used in the different heating and cooking processes in the plant, the engineer soon convinced the management that the central-station figures, no matter how attractive, would be an expensive proposition. It was now up to the engineer to provide, if possible, some sort of stand-by service, and he solved the problem as follows:

In the room adjoining the engine room, mounted on the wall between the two rooms, was a 15-hp. motor belted to a lineshaft. This machine was never run at night or on Sunday and was idle part of the time during nearly every day in the week. The motor had originally been used for a generator and had been driven by a small engine, which had been taken out and stored in the boiler room. The old engine was resurrected, cleaned up, adjusted, tried out and found to be in good condition. Holes were cut in the wall in line with the pulley on the motor, and the engine was placed on a

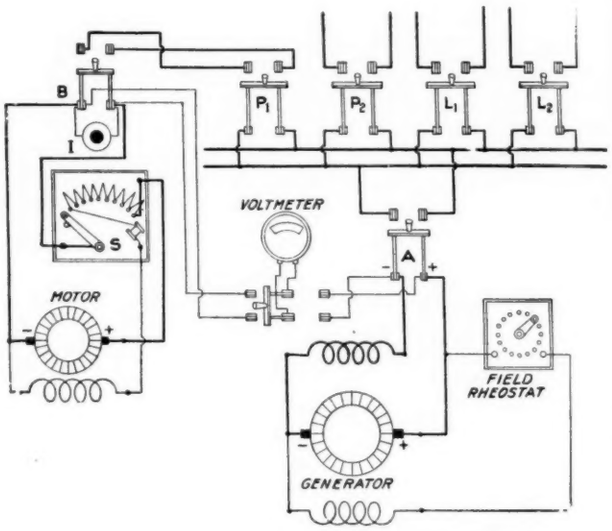


DIAGRAM OF GENERATOR AND MOTOR CONNECTIONS

concrete foundation built on the engine-room floor in such a position that the engine pulley was in line with that of the motor.

The governor of the engine was adjusted so that, according to the pulley proportions, it should about run the motor at normal speed. A lamp *I*, as shown in the figure, was connected across the motor's switch to approximately determine the voltage of the motor while running as a generator.

When everything was ready, the engine was started and brought up to speed. The arm on the starting box *S* was placed in the running position, and soon the lamp *I* began to glow and came up to full brilliancy.

The switchboard was arranged with four switches, as shown. The two switches marked P_1 and P_2 supplied the power circuits; L_1 and L_2 the lighting circuits of the plant. There was only one other motor on the circuit P_1 besides the one being used as a generator, and the switch to this and the switch P_2 on the switchboard were blocked open so that no one could close them and throw excessive load on the emergency generating unit.

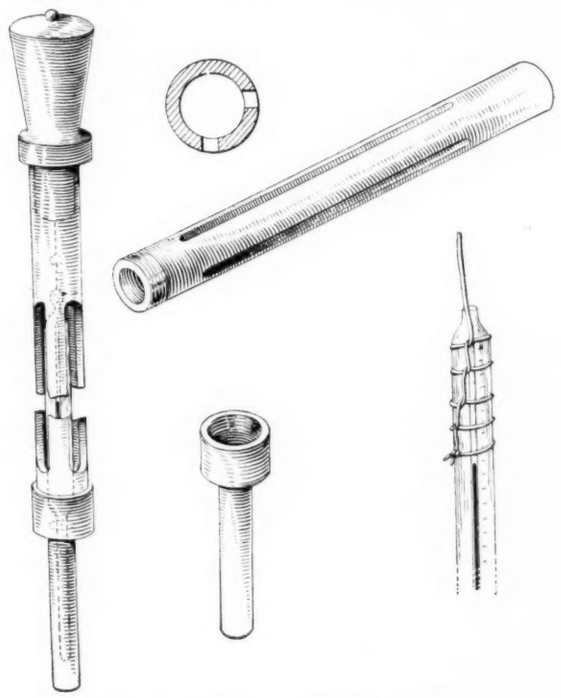
When everything was ready for the change-over, the motor switch *B* was closed, after which the generator switch *A* was opened and switch P_1 closed. The light grew a little dimmer, but this was soon remedied by adjusting the governor to increase speed of engine.

This stand-by unit was used several nights a week and nearly every Sunday for almost two years, when the load became so heavy on the main unit that a larger one had to be installed. The night engineer made another improvement by connecting the voltmeter to a double-throw switch, as shown, so that it could be switched from the main to the emergency unit when it was in operation, and the change-over was then made by paralleling the units, and therefore without interrupting the service. E. W. MILLER.

Minneapolis, Minn.

A Thermometer Guard

The illustration shows a serviceable thermometer guard which is simple to make and easily removed when not in use. Its essential parts are a piece of $\frac{3}{8}$-in. pipe 14 in. long and a wooden cap, the latter shaped to give oily fingers a secure hold and having a hole lengthwise through it for a wire or cord by which to support or move the thermometer. The pipe is threaded at one end and is attached to the ordinary thermometer cup by tapping the cup as shown. The other end is preferably reamed out smooth. Two $\frac{3}{16}$-in. slots are machined in the pipe 90 deg. apart. Then, with the pipe loosely screwed into the cup, one slot can always be turned to face the light. With a hole through the cap, the length of the wire or cord connecting with the thermometer is more readily adjusted than with a screw-eye or a transverse hole in the inner end of the cap.



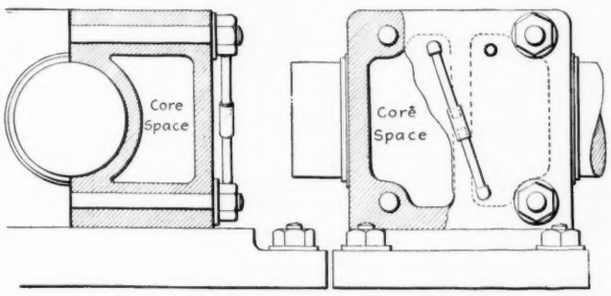
GUARD TO PROTECT A THERMOMETER TUBE

If the eye is broken off the thermometer, tie a soft string around it, followed by a succession of half-hitches. Where excessive vibration endangers the thermometer, a turn of lampwick around its upper end or a small rubber band looped around a few turns will safeguard it. R. MATTHEWS.

Ithaca, N. Y.

Water-Jacketed Pillow-Block Cap

The pillow block of a 30 x 42-in. rolling-mill engine was in the habit of working hot; in fact, it required close attention and a lot of oil, and occasionally some cylinder oil, to keep it from smoking and throwing babbitt. It was cured by circulating water in the cored-out space in the bearing cap through a $\frac{1}{2}$-in. pipe. The bolt holes were in solid metal, and there was a vertical cast-iron partition in the middle, but the core was nearly the size of the babbitt area so that there was plenty of cooling surface. The rough core holes were stopped with wooden plugs into which small iron wedges were driven, on the principle of securing a hammer handle. Four holes for $\frac{1}{2}$-in. pipe were drilled and tapped and piped so that the water entered at the bottom of the space next to the flywheel, discharging from the top to the bottom of the crank side, as shown, and out at the top, after which the bearing was the least of the engineer's troubles. J. LEWIS.



PILLOW-BLOCK CAP COOLED BY CIRCULATING WATER

New York City.

Induction Motor Would Not Operate on Direct Current

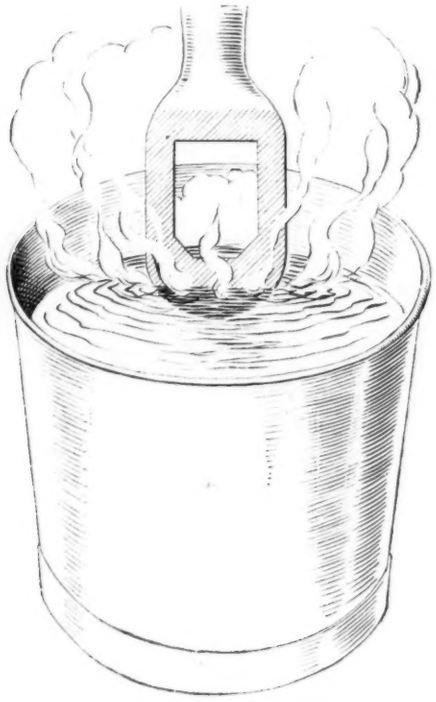
When it is considered that the counter-electromotive force in the armature conductors of a direct-current motor is generated by the conductors being moved across the magnetic field from the field poles, where in an induction motor, the counter-electromotive force is developed by the stator winding cutting the lines of force set up by the current in this winding, it is evident that the alternating-current motor will not operate on a direct-current circuit.

Some time ago, after making some repairs on a small alternating-current motor, I started to give it a running test from a double-pole, double-throw switch connected to a direct-current circuit on one side and an alternating-current circuit on the other. By mistake I threw the switch to the direct-current side instead of the alternating-current side, with the result that the fuses were immediately blown. After trying to make this test two or three times and failing, the motor was opened up and inspected for trouble, but everything was found in good condition. About this time it was discovered that the switch had been thrown to the direct-current side instead of the alternating. Upon assembling the motor and connecting it to the alternating-current circuit, it operated satisfactorily without any further trouble. C. R. BEHRINGER.

Schenectady, N. Y.

Shrinking the "Eye" of a Rod

I have received a great deal of useful information from *Power* and will, in turn, endeavor to supply something myself. I am a machinist and was called out on a job on a Corliss engine (18 x 42 in.) that had



EYE CONTRACTED BY HEATING AND COOLING

developed a bad pound, and I discovered that the brasses were loose in the rod.

To save the customer buying a set of new brasses, I removed the old ones, took the rod to the shop and heated and shrunk it in the manner illustrated. When cooled, I found I had to remove nearly $\frac{1}{32}$ in. to refit the brasses.

B. HARRISON.

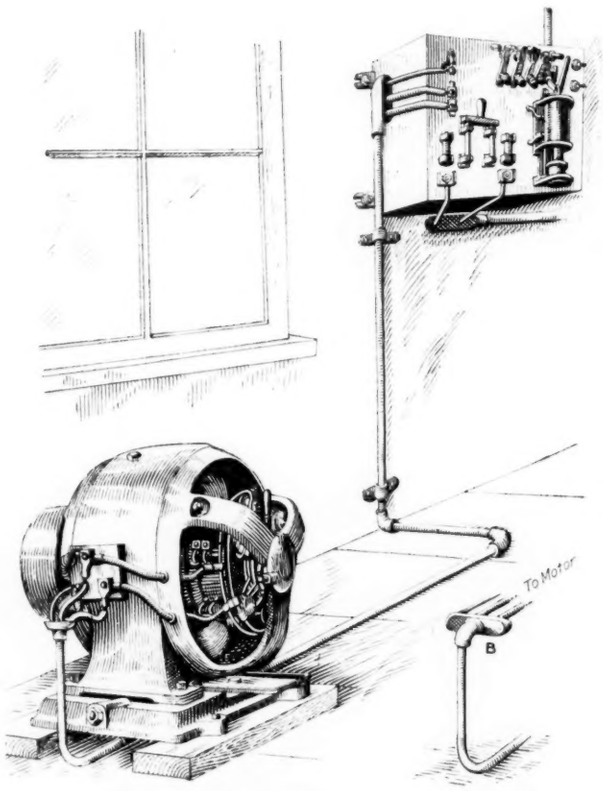
Rochester, N. Y.

An Elusive Ground

A direct-current motor, controlled by an automatic starter, as in the figure, caused trouble by blowing its fuses. The wires from the controller to the motor were run in conduit, and a magneto test showed one of these wires to be grounded. A burned spot showed on the conduit near the control panel, about three inches from the end fitting. As this was believed to be the location of the ground, the wires were disconnected from the motor, and pulled about six inches out of the conduit at the control-board end, and were all found to be in perfect condition. Closer inspection showed the burned spot on the conduit to be on the outside only, evidently having been caused by a live wire coming in contact with the conduit at some previous time. With the wires in this position the magneto was again applied and all rang clear.

Next, the motor and control board were tested for grounds and found to be clear. Inasmuch as everything was now apparently in good order, the wires were again connected to the motor and upon starting all went well for a few hours, then the same trouble again occurred. The next thing done was to test each and every connection on the controller, all of which showed a ground that could not be located. After losing considerable time in this manner, the wires in the conduit were disconnected at each end and again tested, this time showing a ground on one of them.

The wires were then pulled entirely out of the conduit and found to be badly water-soaked, while the insulation was burned from one of them for a length of about four inches where the current had been arcing from the conductor to the conduit. A hole had been burned entirely through the conduit at this point, which was directly under the motor and could not be seen until the conduit was removed from the floor. When the lines were moved during the first inspection as mentioned, it so happened that the bare part of the grounded wire was moved away from the conduit, which accounted for the mysterious way the trouble was cleared at the first trial. It is supposed that after staying in that position for a few hours, it had again moved by jarring caused by the slight vibration of the motor. Upon inspecting the conduit, it was found that water occasionally splashed over from the open jackets of a small vertical compressor near-by and had found its way into the conduit through the end fitting near the motor, which



MOTOR AND CONTROLLER INSTALLATION

was so located as to allow of that happening. This trouble was overcome by placing an elbow on the conduit so as to point the end fitting horizontally, as shown at *B*. When testing for grounds in conduits, both ends of wires should be disconnected and tests made before moving wires.

I. S. CHAMBERLAIN.

Jersey City, N. J.

Inquiries of General Interest

Equalizing Cutoff of Single-Valve Engine—How can the cutoff of a single-valve automatic engine be made the same for each end of the cylinder? J. C.

The cutoff can be equalized for any particular load by adjusting the length of the valve rod, and for most valve gears thus adjusted, the cutoff will be practically equal for all loads.

Exhaust Lap—What is meant by "exhaust lap"? A. C.

The "lap" of a valve is the distance the valve overlaps its port when the valve is in the middle of its travel. Exhaust lap is the lap of an exhaust valve. In a "D" slide valve "exhaust lap" is sometimes defined as the distance between the exhaust edge of the valve and the near edge of the steam port when the valve is in its mid-position.

Chattering of Spring-Loaded Safety Valve—What causes a spring-loaded safety valve to chatter or rumble on its seat, and how can it be remedied? H. H.

Chattering or rumbling occurs when the pressure is just enough to balance the valve, but not enough to hold the valve clear of the seat. The chattering or rumbling will be of duration for less time by adjusting the blow-down ring for greater blow-down.

Greatest Expansion at Temperature of Freezing—When water pipes are burst by freezing, at what temperature does the rupture occur? T. P. M.

Rupture usually occurs while the water is passing to the solid state or when the temperature has been returned to the freezing point, which for quiet water at atmospheric pressure is 32 deg. F. and for higher pressures is about 0.0135 deg. F. higher for each additional atmosphere of pressure. During the freezing process the volume becomes about 8½ per cent. greater than water at the same temperature, or the volume may increase a slightly less amount when the original water has been freed from air by boiling. After ice has formed, a reduction of its temperature causes contraction, and reheating to the freezing temperature causes expansion back to the initial ice volume, and the latter may cause rupture of a pipe from local accumulation of the expansion of volume.

Best Thickness of Fire for Forcing Boiler—Can a boiler be forced hardest by carrying a thick fire or a thin one? L. B. R.

The thickness of fire with which a boiler can be forced hardest depends on the denseness of the fuel bed and the draft available. The greatest heat will result from the thickest fuel bed for which the draft is sufficient to supply air necessary for complete combustion, and the greatest absorption of heat or forcing of the boiler will occur when the air supply is not in excess of 1½ to 2 times the theoretical requirement for perfect combustion. More air becomes a vehicle of heat wasted in the chimney gases. Hence the thickness of fire that is most advantageous for forcing a boiler with a given draft cannot be predicted without recourse to trial or analysis of results obtained with given sets of conditions. Under ordinary conditions of draft, fuel and grate area, the greatest forcing can be accomplished with fires carried 3 to 6 in. in thickness.

Pump Fails To Empty Receiver—The feed pump of a pump and receiver apparently in good working order fails to operate at sufficient speed to keep down the water level in the receiver. How can the pump be made to run faster? N. S.

If the pump is in good working order, it may be that it is prevented from operating at a higher speed by excessive back pressure on the discharge or on the exhaust. To ascertain whether the trouble is with the discharge pipe it should be disconnected, and if the pump then runs at a good speed, the trouble comes from back pressure that may be caused by stoppage, excessive pipe friction or attempting to discharge against excessive head pressure. Putting a bleeder connection in the foot of the steam exhaust pipe will show whether the trouble is not due to back pressure of the exhaust. Such a drip always should be employed and left open so there will be no accumulation of condensation to cause back pressure. If the pump and connections are suitable for obtaining normal speed when the float-operated valve is held open, then if it will not work fast enough when operated by the float-controlled valve it may be assumed that the float is set too high or is otherwise prevented from opening the float-controlled steam-supply valve.

Size of Conductors for a Direct-Current Motor—How can the size of the conductors be determined for a 25-hp. 220-volt motor, full-load current 92 amp.? The motor is located 325 ft. from the generator. J. S.

The size of conductors for a two-wire circuit may be found by the formula,

$$\textit{Circular mils} = \frac{21.4ID}{E_d}$$

where I = the current in amperes, D = the length of the circuit one way in feet, and E_d = the volts drop in the line. The volts drop should not be allowed to exceed 5 per cent. For distances under 500 ft. 3 per cent. is a better practice. As 3 per cent. of 220 volts is 6.6, then,

$$\textit{Circular mils} = \frac{21.4 \times 92 \times 325}{6.6} = 97{,}000$$

The nearest larger standard size is a No. 0, B. & S. conductor. This is also the smallest size that can be used in this case, since the National Board of Fire Underwriters' Code specifies that for direct-current motors the circuit capacity must exceed the normal rating of the motor in amperes by 25 per cent. A No. 0 rubber-covered conductor is rated at 125 amp., therefore it has ample capacity to meet the code requirements for a motor rated normally at 92 amperes.

Boiler Horsepower and Coal Required to Heat Water—With evaporative economy under actual conditions of 7 lb. of water per pound of coal and steam at 90 lb. boiler pressure, what quantity of steam and of coal would be required to heat 22,000 gal. of water from 40 deg. F. to 160 deg. F. and what boiler horsepower would be required to heat the water in 10 hours? H. S.

Each pound of water would receive 160 — 40 = 120 B.t.u., and as 22,000 gal. of water would weigh 22,000 × 8⅓ = 183,333 lb., the water would receive 183,333 × 120 = 21,999,960 B.t.u. A pound of steam at 90 lb. boiler pressure contains 1187.2 B.t.u. above 32 deg. F., and when condensed and cooled to 160 deg. F., or 128 deg. above 32 deg. F., each pound would part with 1187.2 — 128 = 1059.2 B.t.u. and under the conditions raising the temperature of the water would require 21,999,960 ÷ 1059.2 = 20,770 lb. of steam. With a boiler economy of 7 lb. of water evaporated per pound of coal, this would require 2967 lb. of coal. A boiler horsepower is equivalent to the evaporation of 34½ lb. of water from and at 212 deg. or 33,479 B.t.u. per hour, and as the heat transmitted to the water would amount to 21,999,960 ÷ 10 = 2,199,996 B.t.u. per hour, the expenditure of steam for heating the water would be at the rate of 65.71 boiler horsepower. The estimates given do not include any allowances for heat lost by radiation from the surfaces of the water heater or the steam-supply pipe.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

How Fuel May Be Saved

Two papers presented before the Providence Engineering Society, one by Prof. William H. Kenerson, of Brown University, and the other by Henry W. Ballou, of Jencks & Ballou, consulting engineers, discuss means for the alleviation of the present serious fuel situation and the prevention of waste in the use of steam.

THE Providence Engineering Society held one of its most successful fuel-conservation meetings, Wednesday, Feb. 13, at its headquarters, 29 Waterman St. The meeting was under the direction of the Power Section and was presided over by Warren B. Lewis, of Providence. The first paper, "The Fuel Situation as It Confronts New England," by Prof. William H. Kenerson, of Brown University, Providence, and a paper on "The Abuse of Steam," by four local engineers, read by Henry W. Ballou, follow:

The Fuel Situation as it Confronts New England

Two-thirds of the coal mined in this country is used for generating steam, and of this it is probable that 10 per cent., at least, can be saved. Instead of a shortage of 50,000,000 tons of coal this year, it is likely that there might have been an actual excess over requirements if the preventable wastes had been eliminated. The large public utilities and some of the more progressive manufactures have long since carefully studied and met the situation, but to many users fuel has been such a relatively small item in the total cost of production that the desirability of saving in this direction has not occurred to them. So long as the wheels go round and the plant is comfortably heated, and coal can be easily obtained when wanted, there are too many things of greater immediate importance to claim attention. Now it is not only a desirable economy but a patriotic duty to conserve coal. It has been my good fortune to know a considerable number of the men who immediately control the coal pile, and I know that many are well informed and desirous of getting the most out of fuel. For example, the National Association of Stationary Engineers conducts educational lectures by experts. The burning of coal is a complex chemical problem, and it is no more reasonable to equip a man with a nicked shovel and a woolen cap, which he can use as a pad to hold a hot slice bar, and then expect him to get the best results out of the fireroom, than it would be to turn a chemist loose in a dye works, without balance and graduate, and expect him to get uniform and satisfactory results. And so you see that it is very necessary that we educate the man who hires the man who shovels the coal. He must know what is involved in the burning of coal and that the knowledge of his fireman cannot be utilized unless he is given some facilities which will help him to determine the conditions of his plant and some expert advice from time to time in solving problems as they arise.

In principle, however, the burning of coal is a simple matter. All that is necessary is to thoroughly mix the proper proportions of fuel and air and maintain the whole, including the gases evolved, at such a temperature that the chemical action resulting will be accompanied by the maximum evolution of heat. Then all that remains is to transfer as much of the heat as possible into the water in the boiler. The manufacture of pig iron is just as simple. All that is necessary is to mix the right proportion of iron ore, coke and limestone together, maintain a proper temperature by supplying air to the burning coke and draw off the iron, slag and gases from the blast furnace. But in the latter case the ingredients are carefully weighed and the resulting product is analyzed, all under the eye of an expert chemist, while in the boiler room reliance is often placed on more or less shrewd guessing and no fault is found unless the steam pressure drops. If the guess is wrong and too much air is used, a lot of heat is lost. If the guess is wrong and too little air is used, still more heat is lost. In either case the loss can be made up by simply shoveling in more coal, and nobody knows the difference and nobody cares. Every steam plant needs certain facilities for the determination of facts, together with intelligent supervision. Please do not understand by this that I advocate elaborate plant tests or analyses of fuel at this time. At present we will not question a lump of coal regarding its pedigree if it chances to come our way nor condemn it if it does not contain 14,500 B.t.u. per pound. We are overjoyed to get any kind of coal. Certainly in many cases a complete plant test would be a waste of time and of money. But to deprive the boiler room of measuring devices which show what is going on is as absurd as it would be to deprive the merchant and manufacturer of the yard stick, quart measure or set of scales. The boiler room should at least be provided with means for measuring water and weighing coal, and in addition it would usually be well to provide means for analyzing flue gases. Large sums of money are spent in the boiler and engine rooms and it is as essential that some system of accounting be installed as in any other part of the plant. Incidentally, this makes possible a bonus system based on fuel saved, which in many cases has worked out well. Entirely apart from such a system, however, the men who run steam plants will, in nearly all cases, welcome the opportunity to know the facts that they may better the conditions. Although I have studied many steam plants, I have yet to meet a man in charge who was in any way antagonistic. In most cases they are eager to help in improving conditions. It remains for the manufacturers to capitalize that interest by assisting them with measuring appliances, competent advice and supervision. The return in dollars and cents would be well worth while, and at the same time the present coal crisis would be relieved in the most sensible and logical way.

There is one other way in which many plants could save fuel. Power can be produced in the large central stations far more cheaply than in some small isolated plants. Where there is relatively little use for exhaust steam either for heating purposes or in the processes, coal can be saved by purchasing the power.

The Abuse of Steam

The aim of this paper is to contribute to the current public discussion on the conservation of coal. It is an endeavor to combine and set forth some of the views of four local engineers who have had experience with the more popular methods of wasting steam in Rhode Island.

There is today within fifty miles of Providence an industry employing 5000 people, which is the last word in systematic scientific management. Its prime movers consist of no less than six small noncondensing engines. For half of the year nearly all the exhaust steam belches to the atmosphere; for the other half a large part is used for heating. The hot drip from the heating system, instead of being returned to the boiler, flows to the sewer, while the annual bill for the feed water amounts to several thousand dollars. There are literally hundreds of similarly flagrant cases.

What the typical Rhode Island manufacturer needs to help him conserve coal is not information about the refinements of the economic use of steam, but ceaseless reiteration of the simplest platitudes about steam. Platitudes as simple as this:

If steam can be seen anywhere out of doors, coal is being wasted.

Another platitude would be:

Are your steam traps and valves leaking coal all of the time? Do you have periodic inspection and reports as to their condition?

These platitudes are ridiculously elementary, but it is doubtful if one plant out of fifty in Rhode Island has any periodic inspection and reports on these vital matters. For illustration, about a year ago the owner of a new plant

using central-station electric power complained that his heating system took too much steam and that his boiler plant was not of sufficient capacity. On investigation it was found that the otherwise frozen ground was soft and moist for a considerable distance around a certain cistern. The bypass on a steam trap serving the sprinkler tank had been carelessly left open, and live steam to the tune of several tons of coal per day had been wasting through the trap into the cistern for several months. This is typical Rhode Island cause of deficient boiler capacity.

Steam Traps—Hundreds of cases come under observation where steam traps are either leaking or are bypassed and where the leakage is a source of direct waste. The discharge from traps is frequently connected directly to the sewer or to mill trenches where leakage is invisible, and waste may go on for months and even years undetected. This subject of leaky traps is a long story, but therein lies a great possibility. Nearly every steam plant has steam traps, and sometimes there are hundreds of steam traps in a single manufactory. Yet it is probable that not one plant in ten has its traps so equipped and connected that they can be readily tested for leakage. It is the opinion of a number of engineers that of all the steam traps in Rhode Island today, probably over 75 per cent. are either leaking, are bypassed or are in some way failing to serve their purpose purely for want of regular supervision.

Lax Operating Conditions—There is a large finishing plant in which, a few years ago, an engineer was "turned loose." Within a few months the load on the boilers was reduced fully 1000 boiler horsepower with practically no expense for new equipment, but simply by stopping gross leakage and waste. The most obviously needful changes were often secured with difficulty or secured only in part. In one department there were three sets of large can driers, each set being served by a 2-in. live-steam pipe and a 6-in. exhaust-steam pipe. Steam was kept turned on in both pipes at the same time, despite repeated protests to the manager, the master mechanic and the chief engineer. Of course the live steam was immediately reduced to exhaust-steam pressure, to the end that large quantities of steam went to waste through the back-pressure valve in a remote part of the low-pressure piping system without the slightest advantage to the driers. This is an excellent illustration of the objections to having high- and low-pressure connections to any one piece of apparatus.

This same plant had a large air compressor driven by a cross-compound Corliss engine. It was desired to carry a nearly constant pressure in the compressed-air receivers, and to accomplish this the engine was throttled by hand, running probably 95 per cent. of the time at a speed below which the valves would cut off automatically; in other words, taking steam the full stroke. This engine was equipped with a surface condenser which was not in operation, the engine exhausting directly to the atmosphere. A test was made of the engine as found running, and again when operating condensing and with the valves cutting off properly. It was found that the saving due to operating the outfit as intended by the makers was in excess of 125 boiler horsepower.

Blowoff Valves—Probably not one steam boiler out of a hundred in Rhode Island has the boiler blowoff valves so arranged that they may be readily tested for leaks. Moreover, it is fashionable to submerge the end of the blowoff pipe in some river or brook so that no offensive steam cloud caused by leakage will be perceptible. The blowoff platitude would be as follows:

Are the blowoff valves so connected that they may be readily tested every day?

Pipe Covering—Pipe covering is almost an axiom of steam economy, yet there is no systematic periodic inspection and recorded report on the condition of this most thrifty means of saving coal. It is a popular custom not to cover the flanges because of the inconvenience when a joint leaks.

Excessive Back Pressure on Engines—Where steam is used for heating and drying purposes, it is often economical to operate engines and other prime movers against back pressures. Under these conditions every effort should be made to have this back pressure as low as possible. In one instance, where a single back-pressure gage was in use, it was stated that 1 lb. back pressure was all that was required. But the gage in use and which indicated a pressure of 1 lb. was found to be nearly 4 lb. in error due to faulty piping, and the back pressure was in consequence nearly 5 lb. The platitude in this case would be:

Test the pressures periodically.

In many cases the back pressure has been reduced owing to a more efficient circulation of steam by vacuum heating systems or other means. Plants running condensing can frequently obtain a better vacuum by eliminating air leaks, etc. It is not unusual to find a poor vacuum caused by insufficient condensing water which latter is caused by obstructions in the piping such as leaves and accumulations of foreign matter.

Back Pressure and Reducing Valves—At least four cases have been observed by one engineer where live steam was blowing directly to the atmosphere in large quantities through the low-pressure steam system. These were in the case of a supposedly insufficient supply of exhaust steam, where live steam was being admitted to make up the supposed deficiency. At the time the live steam was being admitted through a reducing-pressure valve or by hand control, the back-pressure valve was partly open, allowing the escape of steam direct to the atmosphere. The remedy is to install properly sensitive back-pressure and reducing-pressure valves so arranged and set as to pressures that it will be impossible for such waste to occur.

Heating Systems—As a general statement it can be said that little or no attention is paid to securing economical operation of heating systems for buildings. Many plants operating noncondensing engines have a surplus of exhaust steam available for heating at all times when the prime movers are running. Under these conditions this steam is likely to be carelessly used, there being a feeling that because it is exhaust steam and there appears to be no other use for it, it is not necessary to use it economically, the result oftentimes being that radiation is not properly trapped and that various drains and bleeders discharge directly to the sewer. Under these circumstances waste of live steam occurs at night and on holidays, at such times as the heating system must be operated with live steam, which in this climate in an ordinary manufacturing plant is a considerable number of hours yearly. Obviously, all open ends become sources of waste when live steam is in use.

Exhaust steam, where available, can frequently be substituted for live steam in heating coils with slight changes in the equipment.

In some cases it has been found possible to extract a certain amount of steam from a compound condensing engine or turbine, such steam first performing a certain amount of mechanical work and then giving up its latent heat (amounting to 90 per cent. of the total heat) to the heating system. A specific instance may be noted where in a cotton-mill plant, the steam which passes through one of the turbines is used in the heating system during the winter months, the unit being operated condensing in the summer months. This is a change made during the present winter which has resulted in a reduction of the load on the boiler plant amounting to more than 200 horsepower.

Hotel-heating systems are as a rule very wasteful, because there is a great tendency toward overheating. Many mills, office buildings, etc., are overheated during most of the winter months. Automatic temperature regulation is in many cases a desirable and profitable adjunct to a heating system, for it prevents overheating.

Some of the older vacuum heating systems are wasteful in that considerable quantities of water are required at the vacuum pump to assist in maintaining a vacuum. This condition is frequently caused by improper automatic expansion valves on the return ends of radiators, in many cases it having been found that the interiors of the valves have been entirely removed, allowing the steam to be pulled through into the return line. Several cases have been observed where large quantities of water were being injected into the vacuum pump and delivered by the pump to an open heater or receiver, and from there overflowing (in the form of hot water) to the sewer.

Leaks—Leaks in pipe joints and flanges are a source of

waste larger than is sometimes supposed. The cumulative effect of a wee jet of steam moving perhaps a mile a minute during 24 hours a day is considerable.

Most plants keep their piping systems fairly tight where the pipes are in plain view; but leaky joints on hidden pipes, leaky valves on connections between live and exhaust systems and on drains, etc., are common. It has been found helpful in large plants having many piping connections, to go through the plant late at night when everything is quiet (both out of doors and inside), at which time it is easier to detect the sound of escaping or leaking steam.

Large plants should be equipped with valve reseating tools and should use them whenever necessary to maintain all steam valves in proper condition. This is another matter that should have systematic attention.

Heating of Water—It is quite common in plants using large quantities of hot water to find this water being heated by live steam, while at the same time exhaust steam is being wasted to the atmosphere. This matter needs little comment as it is obvious that great economies can be effected by using exhaust steam for this purpose.

Boiling with Live Steam—In cloth-finishing plants and dyehouses there are many processes, the nature of which makes it necessary to boil large tubs of water with direct steam and maintain them at the boiling point sometimes for hours. Large wastes can occur in this operation, because the amount of steam that can be turned into apparatus of this sort is limited only by the sizes of pipe connections thereto. It is evident that the temperature cannot be increased after the liquid reaches the boiling point. This is a difficult matter to control, as the men handling such apparatus are usually not in the least interested in where the steam comes from or in what it costs.

Automatic temperature regulation can be applied to some work of this character under some conditions, but the sovereign remedy is systematic, skilled oversight and eternal vigilance.

Insufficient Boiler Capacity—Another instance of the typical Rhode Island cause of insufficient boiler capacity may not be irrelevant. The management of a thriving manufactory suddenly concluded that its steam supply was inadequate. It was immediately realized that two new boilers and a new chimney and appurtenances were needed, *and in a hurry.* (Intense hurry is apt to be one of the most distressing symptoms of this disease.) It is the usual custom in such cases to ask the gentlemen who sell boilers and other things to supply the engineering. They do engineering free of charge. But in this instance the management called in an engineer. Instead of installing two new boilers, he shut down one of the old ones. At the end of the next year, during which the business had increased by some millions of yards of cloth, the cost of coal consumed had decreased $8000. This saving was attained by stopping the waste of steam in the dyehouse and by using exhaust steam.

Exhaust steam was used to preheat large quantities of water, instead of putting cold water into dye tubs and bringing it to a boil with live steam as was done previously.

Exhaust Steam—There is, on the part of owners and managers, a universal prejudice against exhaust steam. This prejudice also extends to superintendents and foremen, and it becomes virulent with the workmen. They all know that high-pressure steam will make more commotion and racket than exhaust steam. They know that high-pressure steam will make water boil harder. Most manufacturers are confident that there is some magic property in live steam that is lacking in exhaust steam, even at the same pressure; their head dyers tell them so.

A large part of the failure of some exhaust-steam systems is attributable to a feeling that exhaust steam is cheap—doesn't cost anything—and may therefore be wasted with impunity.

A perpetual campaign of education, remonstrance and expostulation is necessary to prevent the waste of both live and exhaust steam in dyehouses and finishing plants. In the previously mentioned plant where the coal bill was reduced $8000 in a year of increasing business, it is safe to say that the gain would have all been lost in the following year if previous conditions of oversight and management had been resumed.

Platitudes for exhaust steam should be about as follows:

Nine-tenths of the coal used in making steam goes into latent heat.

In making steam nine-tenths of the coal is used before we get an ounce of steam pressure.

When you waste exhaust steam, you waste nine-tenths of the coal used in making live steam.

There are many processes where, with slight changes in the method of drainage, etc., exhaust steam may be used in place of live steam. This is particularly true in cloth-finishing plants, paper mills, rubber works and similar industries, where large quantities of materials have to be dried.

One of the most prolific sources of waste is in the throwing away of the condensed steam in the form of hot or warm water. It should be the aim of every manager to see that no heat is lost to the air or to the sewer which may be recovered.

Enemies Within

It is unfortunate that there can be no powerful government or great industry without its traitors. Often such enemies are fanatics who believe they are right while all others are wrong. The anarchist who plants a bomb to correct a seeming injustice risks his neck and is an honest gentleman compared to that Judas in the coal industry who today is allowing the shipment of dirty coal, and accepting record prices for a product he couldn't possibly sell in normal times.

"That's strong language," you say; and I reply, "It isn't strong enough to fit the case." Furthermore, let it be understood I wouldn't make such an accusation if I hadn't seen with my own eyes many times in many places instances of such a reprehensible practice. Yesterday I saw 60 tons of coal that cost a lot of money that couldn't even be burned without being mixed with real coal of decent quality.

The dishonest clerk who short-changes his customer is a thief, but he hurts only a few people and harms himself most. Here is what the dishonest coal shipper does today:

He is damning an industry that has developed through the exercise of greater individual courage and the endurance of more personal hardship than any other important business.

He is causing the finger of public condemnation to be pointed at honest, conscientious coal operators who have spent a lifetime in the organization and development of reputable mining companies.

He is wilfully and certainly bringing about a situation that can have no other outcome than to deprive efficient mining men of control of their own business, and to hasten government direction of mining, if not Federal ownership.

However, these are only a few of the little things. Here is something more serious:

The very existence of this United States depends on our overthrowing German autocracy. The weak link in our entire war program is transportation. This deficiency in the last three weeks has caused our nation a billion-dollar loss through suspended effort.

Here is what the dishonest coal shipper accomplishes.

The railroads of the United States haul about 1800 million tons of freight yearly; approximately 35 per cent. of this freight is coal. Some coal is sold locally and considerable is used at the mines. Assuming that 630 million tons will be shipped over the railroads this year, it will require 12,600,000 fifty-ton cars to move this output.

Nine per cent. of ash is a normal quantity for American coal. If numerous recent investigations are at all accurate, there is at least 9 per cent. additional adulteration in the coal now being shipped in America. Coal carrying 18 per cent. refuse has but 63 per cent. of the fuel value of coal carrying 6 per cent. ash and requires the transportation of 37 per cent. more coal than is necessary. In certain localities the transportation facilities, due to dirty coal, are being taxed as much as 35 per cent. above normal requirements.

With coal carrying 6 per cent. ash, eight boilers are required to generate 300,000 lb. of steam per hour. With 20 per cent. ash, 19 boilers are required. A certain tonnage of coal running 6 per cent. in ash requires 11 cars to transport it; coal having the same fuel value, but running 20 per cent. ash, requires 17 cars to move it.

For every additional 1 per cent. of impurities in the nation's annual coal production the railroads must haul more than five million tons of useless waste. Coal adulteration means more boilers, more firemen, increased fuel demand and more ash handlers. It is further true that as the percentage of ash in coal increases, the percentage of combustible matter lost in the ashes increases.

It is physically impossible to mine and market coal that contains no noncombustible matter, but when the impurities in our total production average more than 10 per cent., a despicable crime is being perpetrated. The coal industry must rid itself of the pirates that would destroy it, and it is urgent that effective action be taken at once.—*Floyd W. Parsons in Coal Age.*

Why Support the A. A. E.?

The following is from a circular issued by the Committee on Ethics and Coöperation, American Association of Engineers, Isham Randolph, chairman, consulting engineer; W. H. Finley, chief engineer, C. & N. W. Ry.; F. H. Newell, head of School of Civil Engineering, University of Illinois.

A question often asked when the A. A. E. is under discussion is "What is the need of another national society of engineers?" The answer is it is because we are awakening to the fact that the engineers are not occupying their full position of usefulness. The curious anomaly exists that although the victories of war and peace are those of the engineer, yet in most of these the engineer is occupying a secondary place; because of this fact he is unable individually or collectively to utilize his ability to the largest good of mankind. For the last ten years this has been discussed in a more or less abstract manner. Morris L. Cooke in 1908 called attention to the fact that while other professions and lines of business have awakened to the need of definite action, the engineers have been singularly conservative. Dr. Talcott Williams has called attention to the fact that the profession which gives "this age in the various works and achievements of engineers its crowning difference from other ages has less weight in public affairs and on public opinion from any other." "Modern life pays little attention to the word of the engineer." "The engineer will never stand where he should in the state until he discharges his duty at this point (of coöperation and information)."

These quotations taken from among scores that might be used, indicate a condition which, while widely appreciated, has not yet been definitely entered upon by any engineering organization in the same way in which the A. A. E. is acting. Unlike other societies its main object is not mainly that of meeting to discuss technical papers, but rather, not neglecting these, to concentrate on the human matters—the things which affect the engineer as a man and citizen as well as an engineer. It goes into employment because it is the foundation for the success of the individual. Other societies have neglected this fundamental point or at least have given it merely perfunctory attention. The American Association believes in doing what other professional and business organizations are doing for the mutual advancement and protection of the highly trained man from the undermining influence by the unskilled or incompetent. It goes into publicity, advertising if you please, not for the benefit of the individual but of all engineers, because it believes that engineers as a whole will be benefited to the extent that the public knows about the work already performed or of the position to be achieved, which can be realized when the public really understands what can be gained in greater health, comfort and prosperity.

It goes into politics, not the partisan kind, but into the science or practice of the original meaning of the word, that of helping to direct affairs of public policy, of the greatest good to the greatest number. It believes that every intelligent, educated man or engineer educated largely at public expense, should individually and collectively devote a part of his time to the affairs of the community, especially those which touch the practice of engineering. Ours is a political government and every citizen is vitally interested in politics and every engineer who does not take an intelligent interest in public questions and array himself in the cause that appeals to his reason and sense of right, fails in duty to himself, to his community and to his country. Engineers have fallen far short of their duties and privileges in this respect.

Why is it that engineers have done so little in this direction? It is because the older societies established precedents that have hampered growth in public affairs. They were early impressed with the danger of being considered unprofessional or falling into the category of commercialism. They have prided themselves on keeping away from the very subjects that are most vital to the majority of members of the engineering societies. There is no class of educated people more bound to traditions in this regard than the engineer, nor none who have made slower progress toward efficiency in their own organizations.

Illuminating Engineers Hold Special Meeting

On Thursday evening, Feb. 14, 1918, in the Engineering Societies Building, New York City, the Illuminating Engineers held a special meeting for the purpose of discussing the saving of coal by lighting curtailment. The meeting was formally opened with a short address by G. H. Stickney, president of the society, after which Preston S. Millar, chairman of the Committee on War Service of the Illuminating Engineers, presented his paper on "Lighting Curtailment." An abstract of this paper will appear in an early issue of *Power*.

The discussion was opened by J. W. Lieb, chairman of the National Committee on Gas and Electric Service, of the Council of National Defense. During Mr. Lieb's address he read a resolution, filed with Dr. Harry A. Garfield, National Fuel Administrator, setting forth what his committee believes to be the attitude of the electric-light and power companies of the country on the question of sign lighting in its relation to national fuel conservation. The resolution minus the whereases read as follows:

Resolved, that the public-utility companies throughout the United States through their organization, the National Committee on Gas and Electric Service, of the Council of National Defense, representing the gas companies—manufactured and artificial—the electric-light and power companies, the water-works companies and the central steam-heating companies throughout the country, pledge their hearty support and coöperation to the national authorities in carrying out any plan or regulation for the saving of fuel, gas, oil or electricity which the national authorities in the public interest may consider it necessary to adopt as a war measure.

Morton G. Lloyd, of the National Bureau of Standards, Washington, D. C., called attention to the tremendous waste of fuel due to overheating our buildings, residences being the most uneconomical and industrial plants almost as bad in their methods of burning coal. Mr. Lloyd took the opportunity to criticize the coal operators of the country for the poor quality of coal that they have been supplying, pointing out that there might be some excuse for doing this if the mines could not produce sufficient quantity, but if the operators' claim, that the coal shortage is due entirely to lack of transportation, is true, then there is no excuse for shipping the extremely low grades about the country.

Many others took part in the discussion, and the general opinion expressed was that every effort possible should be made to save coal by the curtailment of all unnecessary lighting, but that the amount of fuel that could be saved by the elimination of waste in other directions was so great that the possible saving by the curtailment of light becomes almost insignificant in comparison.

Probably one of the most disappointing features to many who attended the meeting was the absence of representatives from the national, state and municipal fuel administrations. Representatvies from each of these bodies had been invited to take part in the discussion, but for some reason failed to avail themselves of this opportunity.

The address of C. M. Griffin should be 114 First St., Newburgh, N. Y., instead of 114 Spruce St., as given in the article on page 183 of *Power* for Feb. 5, descriptive of his condenser-tube cleaner.

Electricity To Solve the Fuel and Transportation Problems

By E. W. RICE, Jr.

President, General Electric Co. and the A. I. E. E.

An address delivered at the opening session of the midwinter convention of the American Institute of Electrical Engineers, held in New York City, Feb. 15 and 16, 1918. The speaker sets forth the tremendous saving in fuel that can be accomplished by a universal electrification of our steam railways, also that at least 50 per cent. increase in available capacity of existing tracks can be obtained by substituting electricity for steam in the operation of the railroads in this country.

MEMBERS of the electrical profession and industry have reason to be pleased with the contributions which they have made for the benefit of the world. While we are glad to think that our science and our industry are fundamentally devoted to the products and conditions of peace, we realize that in the electric light, searchlights, the X ray, telephones, telegraph, wireless apparatus, electric motors, etc., electricity plays an important part in the grim business of war.

We are in the midst of an extraordinary coal famine, due to causes which it is perhaps undesirable for us to attempt to outline. However, I would like to point out how much worse the situation might have been were it not for the contributions of the electrical engineers; and also how much better our condition might have been if our contributions had been more extensively utilized.

Electricity Increased Coal Production

Suppose we assume that the present serious situation is due to a lack of production of coal. It is comforting to consider to what extent conditions surrounding such production have been improved and how the output of our coal mines had already been increased by the use of electrical devices in connection with coal mining—such for example as the electric light, electric coal cutters, electric drills and electric mining and hauling locomotives. I have no figures before me, but I think it is a fair assumption that the output of coal mines should have been increased at least 25 per cent. on the average by the employment of such electrical devices. If this estimate were cut down to 10 per cent., it would still leave a possible increase in the coal produced of something like 50,000,000 tons during the past year.

If, on the other hand, our situation is not due to a shortage in the production of coal, but rather to the failure of the distributive agencies of the country, which is more probable, it is interesting to see how this difficulty would have been largely removed if the railroads of the country were operated by electricity instead of steam.

Where electricity has been substituted for steam in the operation of railroads, fully 50 per cent. increase in available capacity of existing tracks and other facilities has been demonstrated. This increased capacity has been due to a variety of causes, but largely to the increased reliability and capacity, under all conditions of service, of electric locomotives, thus permitting a speeding up of train schedules by some 25 per cent., under average conditions. Of course, under the paralyzing conditions which prevail in extremely cold weather, when the steam locomotives practically go out of business, the electric locomotives make an even better showing. It is well known that extreme cold (aside from the physical condition of the traffic rail) does not hinder the operation of the electric locomotive, but actually increases its hauling capacity. At a time when the steam locomotive is using up all its energy by radiation from its boiler and engine into the atmosphere, with the result that practically no useful power is available to move the train, the electric locomotive is operating under its most efficient conditions and may even work at a greater load than in warm weather. It may therefore be said that cold weather offers no terrors to an electrified road, but on the contrary it is a stimulant to better performance instead of a cause of prostration and paralysis.

But this is not all. It is estimated that something like 150,000,000 tons of coal was consumed by the railroads in 1917. Now we know from the results obtained from such electrical operation of railroads as we already have in this country that it would be possible to save at least two-thirds of this coal if electric locomotives were substituted for the present steam locomotives. On this basis there would be a saving of over 100,000,000 tons of coal in one year. This is an amount three times as large as the total coal exported from the United States during 1917.

Coal Restricts Capacity of Railroads

The carrying capacity of our steam roads is also seriously restricted by the movement of coal required for haulage of the trains themselves. It is estimated that fully 10 per cent. of the total ton-mileage movement behind the engine drawbar is made up of company coal and coal cars, including in this connection the steam-engine tender and its contents. In other words, the useful or revenue-carrying capacity of our steam roads could be increased about 10 per cent. with existing track facilities by eliminating the entire company coal movement.

I have not mentioned the consumption of oil by the railroads, which we are told amounted in 1915 to something like 40,000,000 bbl., nearly 15 per cent. of the total oil produced. This fuel is entirely too valuable to be used in a wasteful manner. It is important for many reasons that such a wonderful fuel as oil should be most economically used, if for no other reason than that it will be needed for the ships of our forthcoming merchant marine, for the tractors that till our fields, and for the motor trucks that serve as feeders to our railways.

The possible use of water power should also be considered in this connection. It is estimated that there is not less than 25,000,000 hp. of water power available in the United States, and if this were developed and could be used in driving our railroads, each horsepower so used would save at least 6 lb. of coal per horsepower-hour now burned under the boilers of our steam locomotives. It is true that this water power is not uniformly distributed in the districts where the railroad requirements are greatest, but the possibilities indicated by the figures are so impressive as to justify careful examination as to the extent to which water power could be so employed and the amount of coal that could be saved by its use. There is no doubt that a very considerable portion of the coal now wastefully used by the railroads could be released to the great and lasting advantage of the country.

Water Power Allowed To Run to Waste

The terrors of these "heatless days" will not have been without benefit if they direct the attention of the people and of our law makers to the frightful waste of two of our country's most valuable assets—our potential water power and our wonderful coal reserves. The first, potential water power, is being largely lost because most of it is allowed to run to waste, undeveloped, unused. The second asset, coal, is wasted for exactly the opposite reason. It is being used but in an extravagant and inefficient manner.

Our waterfalls constitute potential wealth which can be truly conserved only by development and use. Millions of horsepower run to waste every day, which, once harnessed for the benefit of mankind, become a perpetual source of wealth and prosperity.

The amount of coal in our country is enormous, but it is definitely limited. While Providence has blessed us with a princely amount of potential riches in our coal beds, it is known that there is a finite limit to the amount of coal so stored and when this coal is once exhausted, it is gone forever. It is really terrifying to realize that 25 per cent. of the coal that we are digging from the earth each year is burned to operate our railroads under such inefficient conditions that an average of at least 6 lb. of coal is required per horsepower-hour of work performed.

The same quantity of coal burned in a modern central power station would produce an equivalent of three times that amount of power in the motors of an electric locomotive, even including all the losses of generation and transmission from the source of power to the locomotive. Where water power may be utilized, as in our mountainous districts in the West, all the coal used for steam locomotives can be saved. In the Middle and Eastern States, however, water powers are not sufficient and it will be necessary in a universal scheme of electrification that the locomotives be operated from steam-turbine stations; but as I have already stated, the operation of the electrified railroads from steam-turbine stations will result in the saving of two-thirds of the coal now employed for equivalent tonnage movement by steam locomotives.

Electrification Not an Inventor's Dream

It is, therefore, not too much to say that if the roads of the country were now electrified, no breakdown of our coal supply, due to failure of distribution, would exist. What this would mean for the comfort of the people and the vigorous prosecution of the war, I will leave for you to imagine.

Of course this picture, which I have briefly and inadequately sketched, of the great benefits which our country would have received if the roads had been electrified, does not improve our present situation and it may be claimed that any discussion of such a subject at this time is of an academic nature. This point of view is in a sense true, but I think that we can properly take time to consider it because of the effect which it may have upon our future efforts. This picture is not merely an inventor's dream, but is based upon the solid foundation of actual achievement. We have had enough experience upon which to base a fairly accurate determination of the stupendous advantages and savings which will surely follow the general electrification of the railroads; in fact, I think we can demonstrate that there is no other way known to us by which the railroad problem facing the country can be as quickly and as cheaply solved as by electrification.

The solution of the railroad problem would also "kill two birds with one stone" by solving the fuel problem at the same time.

If it is a fact, as has been stated, that the steam railroads of the country have failed to keep pace with the country's productive capacity—the increased output of manufacturing industries, the extension of agriculture and other demands for transportation—it is obvious that if the country is to go ahead, the railroad-transportation problem must be solved and it must be solved at the earliest possible date. It becomes a matter of national importance that the best solution should be reached in the shortest possible time. That solution is best which will give the greatest amount of transportation over existing tracks, in the most reliable manner and, if possible, at the lowest operating cost.

Every Element of Electrification Solved

We electrical engineers would not be justified in being so confident of the benefits of electrification of railroads if every element in the problem had not been solved in a thoroughly practical manner. The electric-generating-power stations, operated either by water or by steam turbines, have reached the highest degree of perfection, efficiency and reliability, while the transmission of electricity over long distances, with reliability, has become a commonplace. Electric locomotives capable of hauling the heaviest trains at the highest speeds, up and down the heaviest grades, have been built and found in practical operation to meet every requirement of an exacting service.

There is, therefore, no element of uncertainty, nothing experimental or problematical, which should cause us to hesitate in pressing our claims upon the attention of the country.

I realize that the task of electrifying all the steam railroads of the country is one of tremendous proportions. It would require under the best of conditions many years to complete, and demand the expenditure of billions of dollars.

The country, however, has clearly outgrown its railway facilities, and it would require, in any event, the expenditure of billions of dollars and many years of time to bring the transportation facilities up to the country's requirements.

It is not necessary that electrification should be universal in order to obtain much of its benefits. It is probable that one of the most serious limitations of our transportation system, at least in so far as the supply of coal is concerned, is to be found in the mountainous districts, and it is precisely in such situations that electrification has demonstrated its greatest value. Electrification of a railroad in a mountainous district will in the worst cases enable double the traffic to be moved over existing tracks and grades.

If a general scheme of electrification were decided upon, the natural procedure would be, therefore, to electrify those portions of the steam railroads which will show the greatest results and give the greatest relief from existing congestion. Electrification of such sections of the steam railroads would have an immediate and beneficial effect upon the entire transportation system of the country, and it is our belief that electrification offers the quickest, best and most efficient solution that is to be obtained.

It may be said that the present is not a propitious time in which to deflect any of the country's money into railroad electrification. I think that in spite of the enormous advantages of which I have spoken, we would be inclined to agree with such a point of view if it were not for the recent unpleasant demonstration of the failure of our railroad-transportation systems to meet the demands placed upon them by the industries, aggravated it is true by the war conditions and also by the unkindness of the weather.

After all, the question for the country to decide is whether we dare to limp along with the present conditions of restricted production, due to limited transportation, at a time when the world demands and expects from us the greatest possible increase in our efficiency and production.

What assurance have we that the present conditions are temporary? And even if they improve, as they will with the coming of warm weather, what are we going to do next winter? Of course, even if we should start electrification at once, we could not have all our railroads electrified by next winter, but we could have a good start, and as Sherman said about the resumption of specie payments, "The way to resume is to resume," so "The way to electrify is to electrify."

College of the City of New York Giving Boiler-Room Course

The College of the City of New York has offered a course in boiler and fuel economy, under Harry Baum, an engineering expert. The course is given at the college on Thursday evenings from 7:30 to 9:18. The first lecture was given Feb. 21, 1918.

The course is intended for such men as building managers and superintendents, operating engineers, firemen, public-school janitors, engineers, library janitors and others who have not had technical training, but who are interested in the subject.

The prerequisites for this course are a knowledge of simple arithmetic, common sense and an interest in the subject. The fee is $7.50, and for city employees $5. The course is under the direction of Frederick B. Robinson, City College, Convent Ave. and 139th St., New York City.

A. I. E. E. Midwinter Convention

The American Institute of Electrical Engineers held its sixth annual midwinter convention in the Engineering Societies Building, New York City, Feb. 15 and 16, 1918. On account of conditions due to the war, the Meetings and Papers Committee with the approval of the board of directors made this convention purely a business meeting, eliminating all entertainment features and excursions, so that instead of the convention occupying three days as in previous years, this season's sessions were curtailed to one and a half days. Four technical sessions were held at which nine papers were presented and discussed. Although, as would be expected, the attendance was smaller at this season's convention than in previous years (280 members and guests registering), it is doubtful if more enthusiasm and interest was ever shown in the meetings.

The first session, Friday morning, was devoted to the subject of "Circuit-Breaker Ratings," President E. W. Rice, Jr., occupying the chair. Mr. Rice addressed the meeting on the solution of the country's fuel and transportation problem by the electrification of our railways. This address appears in this issue, beginning on page 310.

One paper, "Rating and Selection of Oil Circuit-Breakers," by E. M. Hewlett, J. M. Mahoney and G. A. Burnham, was presented at this session. It was read by Mr. Burnham and discussed by Messrs. Hewlett and Mahoney. In this paper the authors discuss the interpretations of the A. I. E. E. Standardization Rules covering the rating of oil circuit-breakers and consider the variable factors involved in the selection of circuit-breakers for various systems. A method is suggested whereby short-circuit characteristics of various systems can be used for determining the proper selection of oil circuit-breakers for average systems. The method does not apply to very large systems or unusual conditions.

In the open discussion on the paper it was made evident that there was a need of some standard for the selection of electrical protective equipment. It was also brought out that, although oil circuit-breakers had been constructed that had ruptured as high as 500,000 kv.-a, there are so many variable conditions in systems on which circuit-breakers are used that it is impossible to give a simple rule covering the selection of circuit-breakers for all cases.

The Friday afternoon session was presided over by Vice-President L. T. Robinson. This session was devoted to the subject of "Meters and Measurements." Four papers were presented. The first, "A New Standard of Current and Potential," by Chester T. Allcutt, was given in abstract by the author. This paper describes a new secondary standard which is proposed as a substitute for the standard cell in certain classes of direct-current measurements. The device consists of a Wheatstone bridge which will balance for but one value of current. Various factors affecting the accuracy and permanence of the device are discussed and a number of curves are given showing the characteristics which have been obtained.

The second paper, "The Thermoelectric Standard Cell," by C. A. Hoxie, was also presented in abstract by the author. It considers a means of obtaining a secondary standard electromotive force by utilizing the voltage of a thermocouple. The standard thermo cell is fundamentally a standard of current, in that it requires a definite value of current to function properly. The operation of the cell consists in balancing the potential across a resistance against the thermoelectric em.f. of the thermocouple. This requires a definite value of current through a filament which is a source of heat for the thermocouple.

"The Character of the Thermal-Storage Demand Meter," by P. M. Lincoln, was read by the author. Following a detailed description of the principle and construction of the thermal-storage demand meter, the author shows wherein it always indicates what may be called "logarithmic average" rather than "arithmetic average" of power consumption, heretofore indicated by practically all demand meters. The inherent faults of the "arithmetic average," or "block interval" meter, are described and examples given demonstrating that the thermal-storage meter alone recognizes the true heating effect that fixes size of equipment and therefore cost that should be assessed against the customer. This paper will be published in abstract in an early issue of *Power*.

During the discussion of this paper the question was raised as to the justification of basing rates upon the maximum demand of the customer, the opinion being expressed that the diversity factor of the load on the system should be taken into consideration. In answer to this question Mr. Lincoln said that the cost of the equipment at the customer's load end of the line justified basing a rate upon the maximum demand of that customer, because the equipment to render service cost practically the same whether the customer used it continuously or for a short period only.

The last paper given at this session, "Measurement of Power Losses in Dielectrics of Three-Conductor High-Tension Cables," by F. M. Farmer, was presented in abstract by the author. This paper describes the method used at the Electrical-Testing Laboratories for measuring the dielectric-power losses in 10-ft. samples of three-conductor cables with three-phase potential applied to the cable. The difficulties encountered and the methods employed to overcome them are discussed in considerable detail. Typical results are given in the form of data for two specimens of cable, one having a low power loss in the dielectric and one having a high power loss in the dielectric. The data are also presented in the form of curves.

The interest taken in this session was evidenced by the large attendance and the length of the session, which lasted from 2:30 until after 6 p.m.

Between the Friday afternoon and evening sessions an informal dinner was served at the Cafe Boulevard, Broadway and 41st St., 225 members and their guests attending. The dinner was followed by an inspiring address by President E. W. Rice, Jr., on what this country has accomplished so far toward the prosecution of the war, and the problems that lie ahead of us to win this great conflict. This lecture will appear in an early issue of *Power*.

The Friday evening session was presided over by President E. W. Rice, Jr., and was devoted to a lecture by Dr. A. C. Crehore, on "Some Applications of Electromagnetic Theory to Matter." Dr. Crehore during his address showed how a number of the conclusions were arrived at mathematicaily as regards the electron theory.

The Saturday morning and last session was called to order by Vice-President B. A. Behrends. This session was devoted to a discussion of "Alternating-Current Commutator Motors." Three papers were presented. "The Polyphase Shunt Motor," by W. C. K. Altes, was read in abstract by the author. "Commutation in Alternating-Current Machinery," by Marius A. C. Latour, the noted French electrical engineer, in the absence of the author was presented by C. O. Mailloux. These two papers are very largely a mathematical discussion on alternating-current commutator motors.

The third paper, "The Secomor—A Kinematic Device Which Imitates the Performance of a Series-Wound Alternating-Current Commutating Motor," by V. Karapetoff, was presented by the author. Mr. Karapetoff had one of his instruments present on which he gave a demonstration of its operation and use. No small amount of attention was taken in this new device to assist in the designing of series-wound polyphase commutating motors, which are beginning to come into quite extensive use at the present time.

Workers for the Shipyards

Because ships are the primary factor in the winning of this war, and because the construction of these ships depends, and will always depend, upon labor, there has been created an organization of workmen known as the United States Shipyard Volunteers, enrolled under the Public Service Reserve. This organization is composed of workmen who are willing to give a good day's work for a good day's pay; workmen who will stand ready, when called upon, to do a particular job for a particular wage in a particular place, and who have enrolled themselves in this organization so that when needed they may be readily reached.

The need of the nation is great. The Shipping Board has the money, the housing of men is being arranged for, the yards are being completed and the materials provided. All that now is lacking is the knowledge of the need that will inspire loyal and efficient mechanics to enroll for service in the yards, though not in a fashion to disrupt the business of the country through the robbing of present industries.

It is urged that mechanics go at once to the nearest enrollment agent of the United States Public Service Reserve of the Labor Department, or to the local enrollment agent of their State Council of Defense, and register themselves as willing to work in the shipyards if needed; then to retain their present positions until called personally for service.

Through the Council of National Defense an appeal has been made to governors, mayors and other prominent officials, to stimulate interest in their communities.

In addition to the card which the volunteer fills out for the Public Service Reserve, he signs the following franked postcard, addressed to Chairman Hurley at Washington:

Appreciating the Nation's imperative need for skilled workmen to build merchant ships with which to overcome the submarine menace, I request to be enrolled as a member of the United States Shipyard Volunteers of the Public Service Reserve. I realize that the World War will be won or lost in the American shipyards. Every rivet driven is a blow at the Kaiser. Every ship turned out brings America nearer to victory.

It is understood that if I am asked to enter shipyard employment, my compensation shall be at the rate of wage prevailing in such yards.

The button which the workmen receive after enrolling bears this inscription: "U. S. Shipyard Volunteers." A service certificate will be given to all who enroll.

The list following shows the kind of trades most needed in shipbuilding, and a particular appeal is addressed to men in those occupations to enroll in the Reserve: Acetylene and electrical welders; asbestos workers; blacksmiths, anglesmiths, drop-forge men, flange turners, furnace men; boilermakers, riveters, reamers; carpenters, ship carpenters, dock builders; chippers and calkers; electrical workers, electricians, wiremen, crane operators; foundry workers; laborers, all kinds; loftsmen, templet makers, machinists and machine hands, all sorts, helpers; painters, plumbers and pipefitters; sheet-metal workers and coppersmiths; shipfitters; structural iron workers, riveters, erectors, bolters up; other trades, cementers, crane men.

Mobilizing the Educational Institutions

It is estimated that within the next six months 75,000 to 100,000 men will be given intensive training in schools and colleges. With a view to mobilizing the educational institutions of the country and their facilities for such special training, there has been created in the War Department a "Committee on Education and Special Training," associated with which committee will be five civilian educators: Dr. Charles R. Mann, of the Carnegie Foundation for the Advancement of Teaching and the Massachusetts Institute of Technology; Dr. James R. Angell, of Chicago, Dean of the Faculties of the University of Chicago; J. W. Dietz, of Chicago, Director of Education, Western Electric Co., President of the National Association of Corporation Schools; James P. Munroe, of Boston, a member of the Federal Board for Vocational Education (which appointment will include the interests of the trade schools and schools of secondary grade), and Dr. Samuel P. Capen, of Washington, specialist in higher education.

Manhole Heads for Heating Mains

Manholes surrounding fittings in the heating mains, particularly high-pressure steam mains, are one of the greatest sources of heat loss. This heat loss is concentrated in the manhole head which is in direct contact with the pavement.

The damage to pavement, particularly asphalt pavement, is a continual cause of complaint from city highway departments and property owners and a continual source of damage claims and expense. The Underground Construction Committee of the National District Heating Association desires to arrive at a solution of these troubles and has sent out the following questionnaire. Replies should be addressed to H. A. Austin, Chairman, 280 Madison Ave., New York.

A. What class of mains do you operate? High pressure steam? Low pressure steam? Hot water? (Give operating pressure.)

B. What type of manhole do you use? Concrete? Brick? Cast iron sectional?

C. How do you insulate the fittings in your manholes? (Give details.)

D. Do you have trouble with pavement around manhole heads? What kind of pavement? Describe trouble and state inside temperature manhole when closed.

E. What valves, traps, fittings, expansion joints, or specials in manhole?

F. Do you pave around manhole head in special manner? (Give details and sketch.)

G. What have you done to overcome heat losses at manholes?

H. What suggestions have you to offer regarding construction of manholes, such as insulating sidewalks, etc.? (Give details and sketch.)

I. What suggestions have you to offer regarding special insulation of fittings in manhole? (Give details.)

Five Powerless Days Saved Coal

The W. S. Barstow & Co., in their weekly news letter No. 59 give some comparative figures of coal saved as a result of the Fuel Administration order for the closing down of industries from Jan. 18-22 inclusive. The following figures are from seven plants operated by the company:

COMPARATIVE FIGURES ON COAL SAVED FROM JAN. 18 TO 22 INCLUSIVE

Company	Average Coal Consumption for a Like Five-Day Period, Tons		Coal Consumption for the Five-Day Period in Question, Tons		Coal Saved During the Five-Day Period in Question Jan. 18-22 Tons
Binghamton Light, Heat and Power Co.	303.40		246.80		56.60
Metropolitan Edison Co.	1,240.00		935.00		305.00
New Jersey Power and Light Co.	179.90		148.10		31.80
Northwestern Ohio Railway and Power Co.	190.42		*207.91		−17.49
Pennsylvania Utilities Co.	1,490.00		850.00		640.00
Sandusky Gas and Electric Co.	236.50		152.50		84.00
Sayre Electric Co.	103.52		97.52		6.00
Totals	3,743.74	—	2,637.83	=	1,105.91

Figures given are in long tons—2,240 lb. * Coal in excess of ordinary consumption used on account of severe storms.

President Wilson Signs Garabed Bill

On Feb. 9 President Wilson signed the so-called Garabed bill. This measure, as explained in the issue of *Power* for Feb. 5, assures to the inventor of the Garabed, or free-energy motor, protection of his rights in the invention for a period of seventeen years, and gives the Government the free use of the device. It also provides for the appointment of a committee of five eminent scientists, before whom the invention is to be demonstrated, to determine whether it is practicable. The inventor, Garabed T. K. Giragossian, of Boston, is now arranging with Secretary Lane for the selection of the committee of scientists. The opinion prevails that these men will be taken from the faculties of such well-known technical institutions as Massachusetts Institute of Technology, Harvard and Tufts. Engineers will await the report of the committee with a considerable degree of expectancy.

In recent discussion of the subject of electrolytic corrosion of steel before the Iron and Steel Institute, it was brought out that, "Water containing carbonic dioxide is electrolytic at adjacent anodic and cathodic areas in a steel surface. These areas may be revealed by use of an indicator of phenolphthalein and potassium ferricyanide. Where iron dissolves, a blue, and at cathodic spots, a pink, reaction is obtained." The quotation is from a letter in London *Engineering*.

Waste of Fuel and the Remedies

At a meeting open to the public, held by N. A. S. E. No. 1, in Fullerton Hall, Art Institute, Chicago, Joseph Harrington, chairman of the Committee on Technical Publicity of the United States Fuel Administration for Illinois, delivered an interesting talk on the "Waste of Fuels and the Remedies."

In his discussion Mr. Harrington had two objects in mind: First, a brief outline for the benefit of nontechnical members present, showing the causes of waste of fuel and the remedies that could be applied thereto in a practical manner; and second, an endeavor to bring out the fact that the stationary engineer, through his control of both steam production and consumption, was handling a necessity of life, and as such should be rated as one of the important cogs in every industrial establishment using power. The technical end of the discussion was intended to show that if the engineer is given adequate assistance in the way of the proper instruments and the necessary moral support, it is possible to save substantial amounts of coal.

Without the aid of certain instruments, Mr. Harrington claimed that it is not feasible to apply measures of economy. In the electrical department switchboard instruments are considered an absolute essential without which a generator would not be started. Voltage can be regulated approximately by the brightness of the lamps, but the method is not to be considered for a moment. It is no more possible, and should no more be countenanced in the boiler room, that the fireman should operate his boiler and judge of the efficiency of the combustion by merely inspecting the fire by eye. While an experienced fireman can approximate the conditions by looking into the furnace, it is impossible for the average man to do so. Instruments are therefore a necessity, and they should be backed up by adequate records.

A record system that does not show the effect of each and every change made by the engineer is useless. Mr. Harrington brought out the point that in undertaking an efficient examination a test should be conducted under operating conditions to show wherein the losses are greatest and division should be made of furnace and boiler losses. With the heat-balance test before him the engineer would then be in a position to locate the loss and apply the remedy. After this the records should show the effect on the plant efficiency of any changes made, and if they fail to do this they are valueless.

Changes should be made one by one in such manner that close records may be kept and the proper credit be given to each change. These records must go to the chief engineer and from him to the plant manager or owner. As the owner is usually nontechnical, the details would neither interest nor enlighten him. The result that the fuel administration is after in this campaign is to reduce the quantity of coal burned to produce a given amount of steam, and unless the changes actually accomplish this, they have not been beneficial. The plant owner, therefore, should be given a data sheet in which this one main significant figure predominates. To get this, two instruments are essential—a coal-weighing device and a water or steam meter. In the larger plants one more step can be taken and that is a regular coal analysis that will permit the engineer to report the number of B.t.u. consumed per thousand pounds of steam from and at 212 deg. This is the ultimate criterion and is the one on which a just comparison can be based.

When the records have been arranged, there is one other matter that must be given attention by the owner. He must consider that the engineer and the engineering department constitute a link in his manufacturing chain that is all-important and without which manufacturing processes cannot be carried on. Instead of considering the power plant in the light of a necessary expense, it must be considered one of the prime factors and be given every support. The engineer himself must be assisted in every possible way in acquiring information about his business; he must be given the tools necessary to efficiently carry on his work, and he must be encouraged in the reporting of results in an intelligent manner so that both he and the owner may profit by the experiences of the past. The plant itself should be put in such shape that operatives can work comfortably and use all the intelligence with which they are endowed. Very high temperatures in the boiler room, dark and dirty surroundings, lack of washing facilities and lack of office space for the engineer, all conduce to indifference and neglect on the part of the men, which in turn results directly in increased fuel costs. One of the most prolific sources of economical combustion is a general toning up and dignifying of the work of handling the power department.

Why a Fire Policy Was Avoided

An application form filled out as a basis for issuing a policy insuring an industrial plant against fire contained the question, "Is steam power, water power, or what other power is used?" This was answered, "Water." The next question was left unanswered, "If gasoline power is used, then describe the location of the engine, gasoline storage tank, spark igniter," etc. Applicants also remitted in payment of a premium based on use of water power only, although a gasoline engine was in auxiliary use in its plant and it was known that this called for a higher rate. The insurance company's representative knew that the engine had been used about three months before and drew attention to the fact that this was not disclosed in the application. The mill, the subject of insurance, burned one night just after the gasoline engine had been shut down. Under these circumstances the Pennsylvania Supreme Court holds in the case of Corbin et al. vs. Millers' Mutual Fire Insurance Co. of Harrisburg, 102 Atlantic Reporter, 425, that the insurance company was not liable for the loss; the statements in the application amounting to a warranty of facts material to the risk, and it being found that notwithstanding the company's representative's previous knowledge concerning the use of a gasoline engine, the company was entitled to assume that such use had been discontinued.

Dog as Power-Plant Adjunct

Where a factory employee was sent on an errand to the basement of a building and was injured by a dog that the engineer of the plant had been permitted by the common employer to keep there, it was decided by the Appellate Term of the New York Supreme Court in the recent case of Barone vs. Brambach Piano Co., 167 New York Supplement, 933, that the accident must be deemed to have been one sustained in the "course of employment," within the purview of the New York Workmen's Compensation Act. The court said:

There is no doubt that the plaintiff was engaged in performing the duties of his employment at the time he was bitten. The presence of the dog, with the employer's implied knowledge and consent, was one of the physical conditions of the plant under which the defendant required the plaintiff to perform his duties. The mere fact that the direct cause of the injury was animate, rather than inanimate, does not alter the result; nor in this view can I see any force in the suggestion that the dog was not especially kept as a watch dog, or for some similar purpose (though I think the proof showed that it was so employed). The right of the plaintiff to a recovery does not, on any theory of which I am aware, depend upon the comparative usefulness to the employer's business of the immediate cause of the injury.

War-Savings and Thrift Stamps

The sale of War-Savings and Thrift Stamps has been made much easier and missionary work much more effective by the use of the blue return post card, Form WS-138. This card is an order for War-Savings and Thrift Stamps to be delivered at your door C. O. D. The blue card provides the simplest, easiest, safest and least objectionable way of obtaining a pledge to buy stamps and the utilization of the card permits a vast amount of better patriotic campaigning. It is also convenient for agents when ordering supplies.

The card explains its utility to all who can read. It does away with uncertainty, difficulty and delay in securing stamps, for Uncle Sam's letter carriers will fill all blue post card orders in the earliest mail, thus eliminating both bother and risk. The cards can be obtained free in large quantities at almost any post office or bank and from the letter carriers.

New Publications

METHODS FOR INCREASING THE RECOVERY OF OIL SANDS. By J. O. Lewis. Bureau of Mines, Bulletin No. 148. Petroleum Technology 37.

In its efforts to reduce waste and increase efficiency in oil production, the Bureau of Mines is investigating methods of increasing the recovering from the underground sources of supply which are the foundation of the petroleum industry and the allied industries wholly or partly dependent on it. In the face of a demand that is increasing faster than the production, and that in the consensus of opinion of well-informed authorities is soon likely to outstrip the productive commodity, it is well to consider whether it is not possible to extract more oil from the known sources of supply. It is universally acknowledged that by the usual production methods much oil is left underground, the general opinion being that at least 50 per cent. of the oil in the field remains unrecovered when the field is abandoned as exhausted. The writer believes from his investigations that the average recovery is even less, and if any considerable portion of this oil being left underground could be made available, it would have a tremendously favorable influence on the petroleum industry.

This publication considers the principles involved in increasing recovery and methods of extracting more oil from the oil-bearing formations than by the usual way of producing. These methods are: The use of gas or vacuum pumps in forcing compressed air or gas through the oil-bearing formations, displacing the oil by water, and further utilization of the natural pressures in the oil-bearing formations. Special attention is being given to a process commonly known as the Smith-Dunn for forcing compressed air through oil-bearing formations because it is believed to hold the most promise for the future.

The article is of interest to power-plant men for the reason that it shows that the Bureau is active in attempting to recover the maximum of oils in the oil field. These oils, of course, are not only used for fuel purposes but for lubrication.

SAFE PRACTICES

Bulletins No. 8, 9 and 10, issued by the National Safety Council, Continental and Commercial Bank Building, Chicago, Ill., are just off the press, "being an orderly presentation in loose-leaf form of accident hazards and the best practices for their elimination." No. 8 (pages 85 to 92 inclusive of the series) pertains to "shafting, couplings, pulleys, gearing, etc. (transmission machinery)," No. 9 (pages 93 to 108), is on "engine guarding and engine stops," and No. 10 (pages 109 to 116), treats of "oiling devices and oilers." These pamphlets may be obtained for 10c. each by addressing the society or Edwin R. Wright, Editor, at Chicago.

They are accepted not only by the 4000 members of the council, but generally, as standard safe practices to protect the lives and limbs of workers. Accident prevention is now recognized as of supreme importance if for no other reason than to keep every man on the job producing materials to help Uncle Sam win the war.

Obituary

James Stackhouse, for many years superintendent of buildings for the John Hancock Mutual Life Insurance Co., of Boston, Mass., died at his home in West Roxbury, Feb. 8. He was in the sixtieth year of his life, and had spent 28 years in the service of the John Hancock Co. Mr. Stackhouse was born in St. John, N. B., and most of his early life was spent at sea as a marine engineer, having made several trips around the world. Entering the employ of the Hancock Steamboat Co., he later became chief engineer of one of the passenger steamers. He was afterward in the employ of the Suburban Electric Co. as chief engineer, followed by a similar position at the Mason Building, on Kilbey St., Boston, which position he resigned to become chief engineer of the building at 178 Devonshire St., now known as the Old John Hancock Building. Mr. Stackhouse was one of the oldest members of Massachusetts No. 1, M. A. S. E., of Boston, and always took an active interest in the welfare of that organization. Edward H. Kearney, who for many years served as chief engineer of the John Hancock Building, under Mr. Stackhouse, succeeds the latter in the position of superintendent of buildings for the company.

Personals

James A. Campbell has resigned his position with the Renfrew Manufacturing Co., Adams, Mass., to take a position as mechanical superintendent with Lever Bros., Cambridge, Mass.

H. W. Fuller has been appointed vice president in charge of operation of the Northern States Power Co., with headquarters at Minneapolis. H. M. Byllesby & Co. announce the creation of this position to relieve R. F. Pack, vice president and general manager, of operating responsibilities which have increased greatly due to the rapid growth of the Northern States organization. Mr. Fuller has been associated with Byllesby & Co. for seven years, devoting a large part of his time to the solution of special operating problems.

H. H. Harrison, of the Merchants Heat and Light Co., Indianapolis, Ind., has a vigorous policy as to patriotic, civic and public matters. His theory is that any institution that works industriously for the good of a city, county, state or nation will in turn be treated generously by the community. In short, in serving the public you are serving the company. Last fall he inaugurated a campaign to send useful Christmas gifts to the French tots who had been crying for a Santa Claus for three long years. The effort put forth resulted in 18,000 gifts sent to the little French children. His company has vigorously pushed Liberty Loans, and is now pushing Food Conservation, Thrift Stamps and Comic Valentines made by celebrated Hoosier caricaturists and authors. These valentines are sold for the benefit of the French Relief.

Engineering Affairs

The Southwestern Electrical and Gas Association will hold its annual convention on Apr. 15 at Galveston, Tex.

The American Institute of Steam Boiler Inspectors of New York City held its regular meeting in the Engineering Societies Building, 29 West 39th St., on Thursday, Jan. 31. The officers of the past year were reëlected as follows: T. T. Parker, president; J. G. Shaw, vice president; M. Fogarty, treasurer; J. H. Pollard, secretary. The annual dinner will not be held because of the conditions caused by the war.

The New York Section of the American Society of Refrigerating Engineers, at its next meeting, Tuesday, Mar. 15, will hear a paper by Charles H. Bromley, associate editor of "Power," on "Some Specific Fuel Wastes and Their Reduction." The paper will be illustrated with lantern slides. The meeting, to be held at Machinery Club, 50 Church St., New York City, will be preceded by a dinner, also in the club. Van R. H. Greene, consulting engineer, 30 Church St., New York City, is secretary of the New York Section and has charge of the arrangements.

The Boston Section of the A. S. M. E., combined with the American Institute of Electrical Engineers on the evening of Tuesday, Feb. 5, at the Massachusetts Institute of Technology to listen to a paper by Prof. Walter I. Schlicter, of Columbia University, on "The Modern Trend of Education." The paper was discussed by Professor Franklin, of Lehigh, Professor Brozel, of Yale, Professor Clifford, of M. I. T., and several other prominent educators. Representatives of the American Society of Mechanical Engineers were Parker H. Kemble, of the U. S. Shipping Board; Captain Foster Veitenheimer; Dr. Ira N. Hollis, president of Worcester Polytechnic Institute; A. L. Williston, of Wentworth Institute; Director Russell, of Franklin Union, and Mr. Hall, of the General Electric Co., Lynn, Mass. These speakers covered the special problems in training for the Army and Navy, as well as for the mercantile marine, munition factories and other industries directly concerned in the prosecution of the war, and particularly in reference to the utilization of existing technical schools in New England for the training of large numbers of men for such service.

Miscellaneous News

A. Newlands, Engineering Chief of the Highland Ry., in the course of a paper on "Water Power in Great Britain," before the Royal Society of Art, said that turbines for a head of 25 ft. cost £4 per horsepower as against £1 per horsepower for a head of 500 feet.

A Boiler Exploded at the plant of the Republic Iron and Steel Co., East Chicago, Ind., on Feb. 18. Two employees were instantly killed and two others died later in a hospital. Of the 29 injured, two are not expected to live. The plant was partly wrecked, with an estimated loss of $500,000.

Radio Engineering at Lafayette—Prof. James T. Rood has started a course in radio engineering in connection with the prescribed course of electrical engineering at Lafayette College. This course was designed and approved by the Signal Corps of the United States Army in order that the engineering students, subject to the selective draft, might enter this course and receive thereby the deferred classification which would enable them to continue in their engineering courses at the college for the balance of the year.

Western States Petroleum Administrator—Prof. D. M. Folsom, head of the School of Mines at Stanford University, Calif., on Feb. 6 was appointed petroleum administrator for the Western States by Mark L. Requa, national oil administrator. Professor Folsom has been serving as chairman of the petroleum committee of the state fuel administrator in California and is one of the leading oil experts of the West. In his new capacity he will have supervision over the production and distribution of petroleum in California, Washington, Oregon, Idaho, Utah, Nevada, Arizona, Alaska and Hawaii. This appointment is taken to mean the abolition of the petroleum committee which consisted of Professor Folsom and two members of the Railroad Commission of California. Professor Folsom has announced that there will be no compulsory licensing of oil producers at present, as this would require the fuel administration to become immediately responsible for operation and production. A system of friendly coöperation rather will be practiced. "It will be necessary, however," he stated, "for all companies to pool their cars and tank ships to prevent shortages and embarrassment in deliveries." No limit is to be placed on fuel-oil consumption so long as storage conditions remain as they are at present."

Business Items

The Plant and Business of the Schutte & Koerting Co., of Philadelphia, has been taken over by the Government as a German-owned concern. Adalbert K. Fischer, its former president, is interned at Fort du Pont, Del., as a dangerous alien.

The Esterline Co., of Indianapolis, Ind., has appointed the Northern Electric Co., of Montreal, as exclusive distributor of Esterline products for the entire Dominion of Canada, and complete information and service may be had at its offices at Montreal, Halifax, Ottawa, Toronto, London, Winnipeg, Regina, Calgary and Vancouver.

The Marion, Indiana, Machine, Foundry and Supply Co. has taken over the entire business, good will, etc., of the Planet Steam Specialty Co., which has specialized in the manufacture of soot blowers for all types of water-tube boilers. Gordon C. Bennett, who was secretary of the latter company, has taken charge of the engineering department to develop the manufacture of a complete line of soot blowers for all types of boilers.

Wright-Austin Co. — After twenty-five years of producing the highest grade of steam specialties in close association, the Wright Manufacturing Co. of Detroit, Mich., the Austin Separator Co. and the Murray Specialty Manufacturing Co. have combined their interests under the name of Wright-Austin Co. The high standards of manufacture and service which have been jealously guarded by the older concerns will be maintained. The business will be continued at the present address and under the direction of the same officials as heretofore.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 21, 1918	One Year Ago	Feb. 21, 1918	One Year Ago
Buckwheat	$4.60	$2.65—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	.....	.....	.....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Feb. 21, 1918	One Year Ago	Feb. 21, 1918	One Year Ago
Clearfields	.....	$3.00	.....	$4.25—5.00
Cambrias and Somersets	.....	3.10—3.85	.....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 21, 1918	One Year Ago	Feb. 21, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$7.25—7.50
Buckwheat	4.30—5.00	2.75	5.50—5.80	6.25—6.50
Barley	3.25—3.50	1.95	4.00—4.25	3.50—3.75
Rice	3.75—3.95	2.20	4.50—4.80	4.50—5.00
Boiler	3.50—3.75	220	.....	3.25—3.50

Bituminous smithing coal, $4.50—5.25 f.o.b.

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken; Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Feb. 21, 1918	One Year Ago	Feb. 21,1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Feb. 21, 1918	One Year Ago	Feb. 21, 1918	One Year Ago	Feb. 21, 1918	One Year Ago
6-in. lump	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.50-2.75
2-in. lump	2.65-2.80	.....	2.65-2.80	.....	2.65-2.80	.....
Steam egg	2.65-2.80	.....	2.65-2.80	.....	2.65-2.80	.....
Mine-run	2.40-2.55	3.00-3.25	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen	2.15-2.30	3.00-3.25	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Calif., Red Bluff—City is having plans prepared by E. A. Rollison, Arch., Redding, for the erection of an electric lighting plant.

D. C., Wash.—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at various Navy Yards, under Schedule No. 1697, steam and water orass, air, bibb, hose, pet, cutout oil, and stop cocks; Schedule No. 1698, steam and water composition bends, Y-branches, caps, couplings, crosses nipples, plugs, tees and unions, steam and water screwed reducing bushings, elbows and locknuts.

Iowa, Bloomfield—City plans to improve its electric-lighting plant and install new equipment including 2 electric generators, one 225 kw. and one 75 kw. alternating current, and two 150 hp. boilers.

Ky., Walton—The Walton Electric Light Co. is in the market for a 25 kw., 250 volt, 220 r.p.m. D. C. generator for direct connection through flexible couplings, a 10,000 gallon horizontal oil storage tank, 6-8 ft. in diameter, 3-16 in. shell and ¼ in. heads.

Mass., Everett—The J. Duncan Co., 7 Fulton Place, Boston, is in the market for machine lathes, blacksmith power punches, cutters, bolt drivers and all machinery used in small structural iron work.

Mass., Everett—The Town plans to install equipment in its incinerator to include a 3½ x 40 ft. conveyor belt, baling presses and binds with appurtenances. About $7,000 is available. A. Varney, Town Engr.

Miss., Clinton—City plans to build a brick addition to its electric lighting plant and install a 50 hp. engine. Estimated cost, $8850. A. Latimer, Mayor.

Mo., Kahoka—City plans to extend its electric transmission line from here to Luray, Williamstown, Clark City and Medill, about 16 mi. L. R. Sherrill, Supt.

Mo., Ozark—The Finley Light Co. plans to build an electric-lighting plant. Estimated cost, $15,000. G. T. Breazeale, Mgr.

Neb., Sidney—The Town will receive bids until March 12 for furnishing and installing one 250 hp. steam engine, two 200 hp. steam boilers, one 200 kv.-a. 60 cycles, 2300 volt, A. C. generator, 1 steel smoke stack, feed-water pumps and automatic stokers, two 150 hp. internal-combustion oil engines and one 10,000 gallon fuel tank. R. D. Salisbury, 1415 East Colfax Ave., Denver, Colo., Engr.

N. J., Camden—City plans to build an electric-lighting plant. L. E. Farnham, City Engr.

N. Y., Chenango Forks—The Binghamton Bridge Co., Press Bldg., Binghamton, plans to build a concrete dam, 150 ft. long, a brick and steel power house and steel penstocks and install two 250 kw. water turbine-driven generators. Noted Nov. 27.

N. Y., Jamestown—The Crescent Tool Co., 200 Harrison St., plans to build a power station and concrete coal storage binds. New machinery, including a 1000 kw. steam turbine generator set and boilers will be installed. C. R. Swisshelm, Sales Mgr.

N. D., Maddock—City is having plans prepared by W. E. Skinner, Engr., 714 Plymouth Bldg., Minneapolis, Minn., for the erection of an electric-lighting system. Estimated cost, $7000. Noted Oct. 23.

Ohio, Youngstown—The Mahoning and Shenango Ry. and Light Co. plans to build a transmission line from here into the Mosier District. R. T. Sullivan, Mgr.

Okla., Chandler—The Washita Electric Power Co. plans to build a 50 x 75 ft. brick and concrete power house and improve and extend its distribution system. R. K. Johnston, Pauls Valley, Secy.

Penn., Philadelphia—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at Navy Yard, Philadelphia, under Schedule No. 1698, steam and water brass joints.

Penn., Philadelphia (Kensington)—L. S. Leberman is having plans prepared by A. J. Sauer & Co., Arch., 908 Chestnut St., for the erection of a 1-story, brick and concrete power plant, including the installation of pumps. Estimated cost, $10,000.

S. D., Mitchell—City is having plans prepared by Burns & McDonnell, Engr., Interstate Bldg., Kansas City, Mo., for improvements to the electric lighting system.

Tenn., Hampton—J. H. Eden plans to rebuild his electric-lighting plant which was recently destroyed by fire.

Tex., Canyon—The Canyon Power Co. plans to rebuild its plant which was recently destroyed by fire. J. K. Boring, Ch. Engr.

Tex., Del Rio—C. A. Lindsey, Wichita, Kan., and associates, plan to build 1 or 2 hydro-electric plants in connection with a large irrigation project.

Wash., Puget Sound—(Bremerton P. O.—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at Navy Yard, Puget Sound, under Schedule No. 1698, steam and water brass joints.

B. C., Vancouver—The Ontario Power Co. plans to issue $1,000,000 bonds; the proceeds will be used to build additions to its plant.